THE

ELECTRICAL REVIEW.

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OIL INSULATION.

THE use of oil as an insulator has now been before the public for a good many years, and has been the subject, more especially in the last year or two, of much discussion; but there still appears to be a good deal of uncertainty as to the behaviour of oils under the various conditions to which they may be subjected in practical work. The paper read by Prof. Hughes, at the Institution of Electrical Engineers, the lectures given by Mr. Nikola Tesla, and the paper by Prof. Elihu Thomson on "Induction by High Potential Discharges," have all advocated the use of oil as an insulator, especially when very high pressures are to be used, the chief advantage claimed being the power of the oil to restore the insulation after it has been pierced by a discharge; but in the discussion on Prof. Hughes's paper, the existence of any such advantage under the ordinary conditions found in an electric light circuit was questioned by more than one speaker, and doubts were also expressed as to the applicability to practical work of other results obtained by Prof. Hughes.

Whether this is so or not, however, in no way detracts from the credit due to Prof. Hughes as an original investigator, or as the first electrician to practically recognise the possibilities of oil as an insulating medium for submarine and underground cables, more especially as at the time he commenced his experiments, and took out his patent, the conditions of working which now exist were unheard of; and the paper which he read cannot fail to be of interest to all electricians, since it gives the history of how Prof. Hughes, having conceived the idea of an insulating medium which would repair a fault in itself, was led by the fact that Faraday had shown that oil of turpentine was a good insulator, to commence a series of experiments on various oils, so as to find out which was the most suitable for his purpose. The results arrived at, as shown in his patent specification (which describes a conductor coated with gutta-percha, india-rubber, or fibrous material, placed in a tube of gutta-percha or other material containing a semi-fluid restorative medium, preferably rosin oil rendered viscid by the addition of rosin or the solid residuum obtained from the distillation of palm oil), prove how far ahead he was of other experimenters who entered the same field many years later; as some of the most serious difficulties met with in the early days of Brooks's underground, or Johnson and Phillips's overhead systems, were due to the use of oils, which have since been found to be much too light; and it has only been by abandoning them and using heavier and more viscid oils of the kind proposed by Prof. Hughes, that these difficulties have been overcome. It is, however, interesting to note that, although Prof. Hughes was the first to propose the use of oil for insulating cables, the advantages of oil insulation for other purposes, had at even an earlier date attracted the attention of another experimenter, M. Jean, who immersed his Ruhm-

korff coil in a bath of spirits of turpentine, and by this means was enabled to greatly increase its sparking power. The proofs of this were given in a recent communication, by Mr. A. M. Tanner, to *L'Industrie Electrique*, and were referred to in a leaderette in our issue of the 4th inst., to which we would refer the reader for further details, and for extracts from the *Comptes Rendus*, and from a report by M. du Moncel, in which accounts of the experiments were published.

Reverting, now, to the question of the practical use of oils, we propose to refer briefly to several points raised in the paper, or in the discussion which followed it. Prof. Hughes found in his experiments that there were great irregularities in the insulating qualities of different samples of the same oil, and these results have been confirmed by other experimenters, so that it is of the utmost importance that all oils, before being used, should be subjected to electrical tests, and that experiments should be made to determine the cause of the irregularities. It is not merely a question of insulation resistance, but also of resistance to disruptive discharge; but as regards the latter, the different results obtained by various experimenters are only partly due to variation in the quality of the oil, the method of testing employed accounting very often for the greatest part of the difference. For example, Prof. Hughes using a Wimshurst machine, and sparking between a half-inch sphere and a disc, found that with an impulsive rush he could pierce 4 inches of air with the same pressure that was required to pierce $\frac{1}{19}$th of an inch of rosin oil, and that the superiority of the oil was more marked when very high pressures were used; Mr. Campbell Swinton, working with an induction coil, and sparking between a point and ball in air, and a point and disc in oil, found that 2·75 inches of air required the same pressure to pierce it as one inch of rosin oil, and that one inch of air offered the same resistance as one-tenth of an inch of oil; whilst other experiments made with an alternating current transformer have shown that, with such pressures as 10,000 volts, rosin oil offers a resistance to disruptive strain, which varies according to the quality of the oil from about six times that offered by air down to an equal resistance.

When such different results as those cited above may be obtained, it seems absolutely necessary that all tests, if they are to be of practical value, should be made with apparatus which, like the transformers used on electric light circuits, are capable of giving a considerable current, and which give a mean E.M.F. not very far removed in value from the maximum E.M.F. This latter point is, we believe, of considerable importance, as although it is the maximum E.M.F. which will determine the striking distance in air, it is probable that the mean E.M.F. plays an important part in determining the striking distance through solid and liquid insulating materials. When we come to consider the restorative powers of insulating oils, that is, the power of repairing a fault due to the oil being pierced by a discharge, this question of the apparatus used to obtain the electrical pressure becomes of the first importance, since the oil in the path of the discharge becomes carbonised, and the extent of the carbonisation depends on the current passing between the electrodes.

Prof. Hughes did not appear to recognise this, and referred to Mr. Tesla's results with oil insulated transformers as confirming his own, and as practically proving the restorative powers of oil under all conditions; but in both cases, as also in the experiments made by Prof. Thomson, the current transmitted through the oil must have been very small. Mr. Gray and Mr. Swinburne, during the discussion, both spoke to the absence of restorative power, when there was horse-power behind the spark, and other experimenters have, we understand, found the same results. Of course, in a thin oil, with plenty of space for circulation, the disturbance caused by the production of bubbles of gas distributes the particles of carbon, and prevents the formation of a conducting chain between the electrodes; but when the circulation is impeded by the fibrous covering of the conductor, a conducting chain is formed which will allow of the spark passing whenever the current is switched on again. In thick viscid oils, such as are recommended by Prof. Hughes, the circulation is so slow, that the effects are more marked; indeed, we have seen an arc re-formed with only one-fifth of the pressure that was originally required to pierce the oil; and when we consider further that the fibrous covering of the conductor will, as Mr. Swinburne pointed out, itself be charred when there is much energy in the arc, we can only come to the conclusion with him, that whether oil is used or not, the transformer or other apparatus will be destroyed by a single breakdown of the insulation.

Taking the paper and discussion together, we believe that the general impression left by them must be that very little is as yet known with certainty of the behaviour of oils, and that, although for certain applications they will undoubtedly be found useful, we cannot expect them to be generally employed as insulators until experimental work on a practical scale has supplied us with much fuller data than we at present possess.

"VEGETABLE ELECTRICITY!"

The first number of a periodical styling itself *The Annals of Electro-homœopathy and Hygiene*, has recently come under our notice. This production obviously has for its *raison d'être* the advertisement of the "Geneva Electro-homœopathic Institute," and is, we suspect, identical with *Les Annales de l'Electro-homœopathie*, and *Die Annalen für Electro-homœopathie und Gesundheitspflege*; at any rate, they are all to be obtained from the Geneva Institute.

Electricians and the medical faculty will wonder what "electro-homœopathy" can possibly mean. A certain section (unfortunately large) of the public will be quite satisfied, inasmuch as the word combines the two shibboleths, "electricity" and "homœopathy." We have carefully read this paper, hoping to be able to discover what it is all about; but we should not like to have to pass an examination in it. Our answers might possibly offend the examiner, especially if he happened to be one A. Sauter, the director (? proprietor) of the "establishment" at Geneva.

The great exponent of homœopathy, Hahnemann, whose work is daily receiving more and more recognition amongst the faculty, gave as the fundamental principle of the system *similia similibus curantur*. Sauter says *complexa complexis curantur*, or, in other words, that diseases are complex, and we must take mixed medicines for them. So far, nothing particularly new. "Homœopathy has recourse to division

and sub-division, and reduces all to an impalpable powder. Electro-homœopathy, on the other hand, develops the forces of the remedies by the natural process of fermentation." How will a chemist receive this? On one page we read that arsenicum and hepar sulphuris were administered in a case of tubercular phthisis. How on earth could these inorganic substances be made to ferment?

But there are more startling things than this. On another page we read that this Mr. Sauter was the first "who developed the active principle of medicinal substances grouped together by the aid of fermentation, and reduced their complexity to harmony. To this force, or active principle, derived from fermentation, Mr. Sauter gave the name of "*vegetable electricity*." This is merely a sample of what every scientist, either medical or electrical, will regard as self-damning. It is either conjuring with words, or deliberate humbug.

This electropathic and electro-homœopathic quackery is a reflection upon the intelligence of the nineteenth century, and is infinitely worse than the iatro-chemistry and medical mysticism of the seventeenth century; though it were a libel to compare Basil, Valentine, Paracelsus, Van Helmont and Glauter with such names as those which the development of advertising has made us familiar with. The medical mysticists were at least earnest men "on the wrong tack," and knew not the "almighty dollar." But the quack lives only for one thing, and can say with Homer (if he knows Latin—he probably doesn't) :—

> Populus me sibilat: at mitri plaudo
> Ipse domi, simul ac nummos contemplor in arcâ.

But to return to the "beneficent science" of electro-homœopathy (Why do these people always pose as philanthropists and public benefactors?). We have tried in vain to discover any explanation of what "vegetable electricity" is. Mr. Sauter, we are told, has succeeded in solving the problem "how to combine into groups, heterogeneous medicinal substances, so that they may develop their utmost power not only as regards their curative virtue, but also as concerns their electric properties, in order to be able to transmit into diseased organism a concentrated application of force analogous to an electric shock." What a wonderful man this is!

As regards what the "fermentation" is, we are informed that "in this operation the vegetable electricity is developed from properties inherent to the elementary substance as happens in mineral waters. Scoutteten has shown that by the movements of sheets of water under the surface of the earth, and by their rolling over granites, gneiss, porphyry, and carboniferous rocks and jurassic strata, *electricity* is developed which gives to the mineral waters their peculiar properties and causes them to be employed in thermal stations to cure chronic diseases."

These people, we suppose, understand the public, and such "explanations" are quite sufficient. "The public likes being humbugged," said Barnum, "and are willing to pay for it."

The most instructive reading in the "Annals of electro-homœopathy and hygiene" is an article in which Mr. Stead's description of Count Mattei and his "electrical" remedies (*vide Review of Reviews*) is dealt with, both Count and journalist are roundly abused, whilst the Count is charged with being an "unscrupulous quack, who has been condemned half a score of times in Italian Courts for calumny, libel, abuse, and breach of contract." But the "key to the whole show" is to be found on the last page, where the "remedies" are advertised; these include globules, ointments, injections, "electricities" at 2s. the bottle, dentrifices, hair washes and velvet powders!

Gas Engine Performances.

WITH reference to the letter in our issue of March 11th, from Messrs. J. E. H. Andrews & Co., Limited, this firm has again called our attention to the performance of the Stockport Gas Engine by sending us data of the running of two of their 14 H.P. nominal motors fitted on board cruisers at Messrs. Palmers, of Jarrow. Both engines are fitted between decks, one on the *Revenge* and the other on the *Resolution*. The figures speak for themselves, says the general manager of the Stockport Company, so we give them herewith :—

H.M.S. *Revenge*.			H.M.S. *Resolution*.	
Ampères	108	...	Ampères	144
Volts	100	...	Volts	100
Hours	11	...	Hours	11

Now, our contention in the Crystal Palace Exhibition article, published in the REVIEW on March 4th, was to the effect that it was questionable whether gas engines when running continuously developed a brake horse-power much, if any, in excess of the nominal rating of the engine. By this we intended to convey the meaning that if an engine is called a 14 or 16 nominal H.P. motor, we cannot expect, except in short trials, to get much more than 14 or 16 horse-power out of it available for converting mechanical work into electrical energy. Messrs. Andrews endeavoured to show that we were in error, but the figures given by them in the issue of the REVIEW to which we refer did not shake our conviction, nor do the results on board the two cruisers of Her Majesty's Navy. The Stockport Company is, of course, well aware that our remarks applied to gas engines generally and not to the Stockport motor in particular, for all of them are rated alike. There is nominal, indicated and brake horse-power, all differing very considerably, the nominal being lowest, indicated highest, and brake horse-power somewhere between the two. Thus if a would-be user, not an engineer, were told that a 16 H.P. nominal engine would give 32 brake horse-power, he would be apt to conclude, assuming he required it for driving a dynamo, and the latter being almost a perfect machine, that he could turn nearly all the brake horse-power into electrical energy; but in everyday running he would find, greatly to his disappointment, that 16 H.P. or a little more, would be all he could reasonably hope for. Is it not time that the "nomenclature" of engine horse-power should be simplified?

Cazal's Electrical Railway, patented in France in 1864.

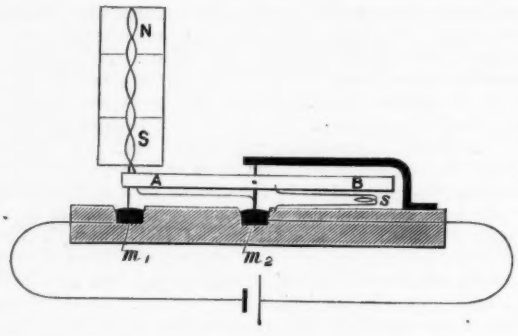
A PATENT has recently been granted in the United States to Mr. Geo. F. Green for a system of electrical railways. One of the claims in his patent is expressed in the following terms :—"The combination of a line of railway, one or more supply stations, electrical conductors coming from these centres extending along the railway and constituted either entirely or partly by the rails themselves, carriages rolling on these rails, rotary electro-dynamic motors fixed on these carriages in order to put them in motion, wheels supporting these carriages on the rails and also serving to maintain continuous connection between the supply stations and the rotary motors." Every electrical railway in which the rails constitute part of the electrical circuit being an infringement of Mr. Green's patent, it is of interest to see to what extent his claims are valid. Although they have been declared valid by the American law courts, it may be worth while, says Mr. A. M. Tanner in an article on the subject appearing in *L'Industrie Electrique*, to examine the French patent taken out by Jean Henri Cazal, dated May 25th, 1864, bearing the number 63,155 and entitled "Electro-magnetic, magneto-electric apparatus, fixed and locomotive motors." In this patent we find described a system of electrical railways comprising : two metal rails in which the electricity circulates, one being positive the other negative, this electricity being supplied from a voltaic or magneto-electric source, and a train consisting of cars, in which the wheels are insulated, with an attachment in front forming the motive wheel, this wheel being the application of the cylindrical electro-magnet to the large surface of attraction described in the patent as a motor, and adapted to this purpose by a few simple and practical additions. Cazal clearly mentions the utilisation of the rails as positive and negative conductors, and goes even further, as he describes a motor mounted directly on a stationary axle in a manner which is analogous to the construction actually adopted in an electrical railway now being tried in the United States.

C

A NICKEL CUT-OUT.

By FREDERICK J. SMITH.

Some years ago, I made several devices for showing how nickel behaved in the magnetic field. My first, was a ring of nickel wire, mounted as the rim of a wheel on thin spokes of asbestos; part of the ring was placed in a magnetic field and then unequally heated. When a certain temperature was reached it revolved continuously. The nickel cut-out is based on the property of nickel, viz., that it loses most of its magnetism at the temperature of about 285° C. In the figure, N, S, are the poles of a steel magnet: it attracts a wire of nickel, twisted on itself as shown, the wire is covered with thin asbestos paper. The nickel wire is carried on one



end of a balanced bar, A, B, and the ends pass into mercury cups, m_1, m_2; in one of these, m_2, the bar revolves. The other end of the wire dips into the meniscus, m_1, the ends of the wires which are in contact with the mercury being of copper. If a current of such a strength be passed through the nickel that the temperature of the latter becomes that at which it loses a considerable part of its magnetism, it is suddenly pulled off the magnet by the spring, s, and the circuit is broken. As soon as it is cold it can be again put against the magnet, and held there till again heated. The currents in the twisted nickel wire neutralise one another, and no interaction between the magnet and spiral takes place. Of the different sorts of contacts I have tried, I find the end of a copper wire sweeping through a meniscus of mercury the most reliable.

ELECTRICAL POWER TRANSMISSION.

We are indebted to the courtesy of the Edison General Electric Company, of New York, for the following description:—

The utilisation of sources of power remote from its point of application has, during the past two years, received considerable attention from electricians in this and other countries; and repeated experiments have demonstrated the practicability of utilising power, by the adoption of electrical methods, which would otherwise be wasted, and of its utilisation to such advantage that projects may be, and have been, carried out which, without the application of electricity, would have been impossible. This has been particularly the case in the mining industry. Lodes of metal are frequently found at great altitudes, where, unless some cheap power can be applied at the required spot, they can never repay working. It is not so long ago that a project to generate power for mining purposes at the foot of a mountain and utilise it economically midway, or at the summit, would have been scoffed at as visionary; but this feat has been accomplished and with complete success.

Probably the best example of this, at the present time, is the large plant which has been installed by the Edison General Electric Company, at the Virginius group of mines near Ouray, Colorado. It is one of the largest, if not the largest, purely mining plant in the world. Every difficulty likely to be met with in work of this nature was encountered in the installation. The pipe line is laid along the side of a rocky canon; the wires from the power house to the mine, are strung partly through dense timber, where they are exposed to damage from falling trees, and partly above timber line, over rocks and snow banks, where the poles and wires are liable to be carried away by snow-slides, and where lightning storms are frequent and violent. The line is nearly four miles long, the voltage of the current 800 volts, and the mine is wet. The relative advantages of the ground return and complete metallic circuit are illustrated, and switches are so arranged that either may be employed, the metallic circuit being used at present. The plant includes a variety of machinery, comprising two pumps, one hoist, one blower, and two motors running mills, indeed, almost everything except locomotives and drills, and these will probably be added shortly. Lastly, the enormous saving that can be effected in many places by the utilisation and transmission of water power by means of electricity is strikingly manifested. Coal at the mines cost $18 per ton, and before the installation of this plant was made, the cost of the power amounted to nearly $40,000 per annum. This sum is saved by the adoption of electric power. An instance is also afforded of unprofitable mines being rendered profitable by the use of cheaper power, for while some of the mines in this group are rich enough in metal to repay working under the most adverse conditions, there are others of lower grade which would have been shut down in case the electric plant had proved a failure, but which, with the plant, will now yield a satisfactory profit.

The foregoing gives a general idea of the nature of the plant and the difficulties encountered in its installation, but an actual visit to the mine is necessary to give a correct conception of the real character of the plant, which is undoubtedly one of the most remarkable in existence. Great credit is reflected on the managers of the mine, who possessed the requisite enterprise and sagacity to expend a large amount of money on a purely speculative experiment, the success of which was regarded as uncertain by even the strongest advocates of electric transmission of power.

If a careful search of the Rocky Mountain region had been made with a view of selecting for the first extensive experimental mining plant, a location presenting every conceivable difficulty, and one which would prove a crucial test to electric power at the very outset, it is very probable that the Virginius Mine would have been chosen.

The Virginius and neighbouring mines, owned by the Caroline Mining Company, are situated near the summit of Mount Sneffles, in the region of perpetual snow at an altitude of 12,700 feet above the sea, and about 5,000 feet higher than timber line. They are reached by a waggon road, open in the summer, but impassable in the winter, when the only route to the mines is by a difficult trail, the lower part of which, denominated the "zig-zag," winds up a declivity so precipitous that burros with their packs slipping from the trail frequently roll down past several branches of the zig-zag before they are stopped by a tree or rock. The upper part extends over a rocky plateau above timber line, and along cliffs where the snow is frequently over 20 feet deep on the level, and where terrific wind and lightning storms are frequent. The lower half of the line from the power house to the foot of the zig-zag extends up a deep canon through a forest of dense timber. The danger of breakage and grounds from falling trees which are frequently blown down by storms and rest on the wires for some time before they can be removed is continually present. The construction of heavy line work over nearly four miles of such ground is an undertaking the difficulty of which is evident, but which can be fully appreciated only by an actual examination; while the maintenance and operation of the plant under the conditions just specified present even more serious difficulties. But although these difficulties are exceptionally great, the enormous expense of transporting fuel to the mines, rendered the advantages of an electric transmission plant so very striking, that the management was induced to make the trial.

The water-power utilised for the plant is in Red Canon Creek, nearly four miles from the mines. The water-power plant consists of a small dam, an iron pipe line, extending along the side of the canon, a distance of about 4,000 feet, giving an effective head of 485 feet, and two Pelton wheels, one 5 feet, the other 6 feet in diameter, capable of developing under that head 500 H.P. and 720 H.P. respectively, or a total of 1,220 H.P., the two wheels being connected to separate shafts, so that either wheel may run the entire

stations. The electric generating plant comprises, at present, one 100 K.W. Edison dynamo and two 60 K.W. Edison dynamos, giving a total output of 293 E.H.P. The length of the line, as previously described, is a little over 19,000 feet. The electric machinery operated at the mines consists at present of two pumps, 60 H.P. and 25 H.P. respectively; one hoist (25 H.P.), two Edison motors, each of 60 H.P., running concentrators and stamping mills and a 15 H.P. blower. The large pump which was erected when the plant was first installed, raises 150 gallons of water, 700 feet per minute, and is of the Knowles duplex type. An Edison standard motor is geared to it by a double worm, one right-hand and one left-hand, working into two spur gears that mesh into each other and operate the pump, the object of the two worms being to neutralise the longitudinal thrust. The smaller pump, which was installed a few months ago, is somewhat similar, the motor, however, being mounted over the pump, with its armature vertical, the weight of the armature counteracting the thrust of the single worm employed. Both pumps have been working steadily and smoothly for several months, and have satisfactorily fulfilled requirements.

The hoist consists of an Edison motor of standard type, but of street car winding and controlling switch geared to the drum through the medium of a friction clutch. By means of the controlling switch and clutch the hoist is under more perfect control than a steam hoist.

The motors for the mills and blowers are of the standard type, and present no exceptional features.

The most serious troubles have been caused by lightning—electric storms in that section of the country being frequent and very violent. This has formed the subject matter of particular study, and special lightning arresters have been devised that give excellent protection. Since their adoption little or no trouble has been experienced from this source.

That difficulties were encountered in the early operation of the plant is not surprising, and the fact that these difficulties have been overcome and the entire plant is operated successfully and satisfactorily under conditions that for severity are not likely to be exceeded anywhere, demonstrates the practicability of electric power for mining and guarantees its success in this field.

ON ELECTROTECHNICAL TERMS AND PHRASES.

BY W. PERREN MAYCOCK, M.I.E.E.

ELECTRICAL nomenclature has expanded at such a rate that a judicious selection of new, and suppression of ancient terms, has hardly yet been possible, or if possible, has not been very widely attempted. If one refers to even the latest contributions to electrical literature, one finds terms that either ought long ago to have been consigned to oblivion, or which are used in a wrong sense.

The use of the prefixes *faradaic*, *galvanic* and *voltaic*, especially dear to makers and users of medical electric apparatus, is no longer necessary, and therefore should be discontinued. There is no difference, I take it, between a "faradaic current" and an "intermittent current," or between "galvano-cautery" and "electric cautery"; but the latter term of each pair sounds much more correct to an electrician.

In the latest edition of Nuttall's Standard Dictionary we still find, *inter alia*, the following terms and definitions :—

"*Faradization*. A method of treating disease by the application of electric currents. *Galvanism*. The department of electrical science which treats of currents of electricity as due to chemical action. *Galvanist or Galvanologist*. One versed in galvanism. *Galvanize*. To affect with galvanism. *Galvanology*. The science of galvanism. *Galvanoplastic*. Pertaining to electrotyping. *Galvanography*. The production, by means of the electrotype process, of plates to print from like those of the engraver. *Voltaism*. That branch of electrical science which has its source in the chemical action between metals and different liquids. *Voltaplast*. A galvanic battery adapted for electrotyping. *Voltatype*. Electrotyping (*sic*)."

Fancy now-a-days the absurdity of calling an electrician a "galvanologist." If language was writ according to our dictionaries we should have something of this sort as a description of the principle of the electric arc :—*One of the most useful applications of galvanism is the voltaic arc, the light emitted by which is caused by the flow of a galvanic current between the extremities of two slightly separated carbon pencils. This, the galvanologist explained, was due to, &c., &c.*

Following is a list of the above-mentioned and some other antiquated terms, their modern equivalents, and, in some cases, their definitions; but many others might be included.

Old term.	New term.	Definition.
Ampèremeter ...	Ammeter	
Coercive force	Retentiveness or permanency	
Electrization ...	Electrification	The state of being electrified
Electrostatic induction ...	Influence	
Faradaic coil	Induction coil	(When with primary and secondary windings)
	Inductance coil	(When with one winding only)
Faradaic current	Intermittent current	
Faradization...	Electro-therapeutics (?)	The treatment of disease by the application of electricity
	Electro-pathology	The science of ditto
Frictional Electricity ...	Static electricity: electrostatics	The science of electricity "at rest"
Galvanic electricity Voltaic electricity	Current electricity	
Voltaic cell or battery ... Galvanic cell or battery ...	Primary cell or battery	
Galvanology ... Galvanism ... Voltaism ...	Electrokinetics	The science of electricity "in motion"
Galvanist ... Galvanologist	Electrician	
Galvanoplastics Galvanography	Electrotyping	
Induction machine	Influence machine	
Self-induction ...	Inductance	
Voltaic arc	Electric arc	
Voltaic pile ...	Dry pile or electric pile (?)	
Voltaplast	... ...	A battery for electrotyping

I believe the use of the term "inductance coil" to signify a coil whose capacity for giving "shocks" depends on the extra currents due to its own inductance (or self-induction), has not before been suggested. Some would contend that this term is wanted for "choking coil;" but the proper name for the latter is surely "impedance coil," not "inductance coil."

Our latest electrical periodical has objected to the use of the terms "influence," "influenced," "influencing," &c., in connection with the phenomena of electrostatic induction (influence), terms which were advocated, if I mistake not, by Dr. Oliver Lodge. It is time that the term, "induction," and its derivatives was reserved for sole use in connection with electro-magnetic and magnetic phenomena. Why write "ampèremeter" when "ammeter" is shorter and more euphonious? Why "voltaic arc" when Sir Humphrey Davy was the discoverer? If the term "induction machine" were at all necessary, it certainly better refers to a dynamo than to a machine for giving charges of electricity.

In discontinuing the use of many terms derived from the great names of Faraday, Volta, and Galvani, we are not likely to forget their pioneer work. The names of the two first are perpetuated in our units, Farad and Volt; while that of Galvani can never be forgotten while galvanometers are used.

If the power of resisting the flow of electricity is called *resistance*, then *conductance* and not *conductivity* should be the term to denote the power of conducting electricity. The ohm is the unit of resistance, therefore the mho should be defined as the unit of "conductance," not of "conductivity" as it almost invariably is. Indeed, this term "conductance" is as yet comparatively unused by electricians, and yet to a

purist in terms, "resistance" and conductivity as reciprocals must sound harsh. The "comparative conductance" or "comparative resistance" of bodies should be called their conductivity and resistivity respectively. Thus we should say that the conductivity of copper is about 6 as compared with iron, while the resistivity of lead is about 11 times greater than silver. The actual value of the conductivity (say in megmhos) and of the resistivity (say in microhms) between two faces of a centimetre cube of any particular body, should represent its "specific conductivity" or "specific resistivity" respectively.

Specific resistivity is the reciprocal of specific conductivity, consequently if the former be expressed in microhms, the latter should be expressed in megmhos, for one microhm = one megmho.

RECIPROCALS.

Conductance.	Resistance.
Conductivity (or comparative conductance).	Resistivity (or comparative resistance).
Specific conductivity (in mhos).	Specific resistivity (in microhms).
Permeance (permeability) or magnetic conductance.	Reluctance (or magnetic resistance).

"Retentiveness" seems a more correct term than "retentivity" for expressing the power of any particular piece of iron or steel of retaining free magnetism. "Retentivity" should signify the "comparative retentiveness" of different samples.

How many electricians would agree as to whether fig. 1 represented a "parallel-series" or "series-parallel" system of distribution.

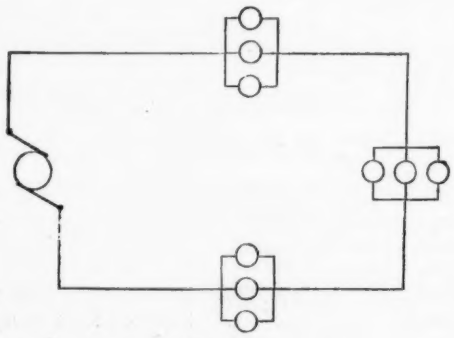


FIG. 1.

I opine that fig. 1 should be taken to represent a series-parallel, and fig. 2 a parallel-series system. For these reasons: If we take the first word to signify the general arrangement of the circuit, then decidedly fig. 1 represents a "series" connection of lamps "in parallel," *ergo*, a series-parallel system. Fig. 2 represents a "parallel" connection

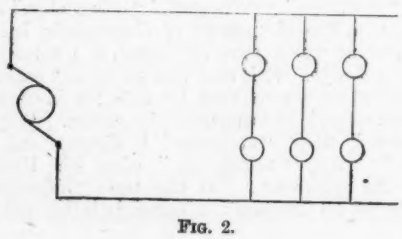


FIG. 2.

of lamps in "series," *ergo*, a parallel-series system. Of six authorities I have consulted, one agrees with the above definitions, one disagrees with them, reversing the names, one confounds the two systems, two do not attempt to define the difference, and the last confuses the multiple-series with the three-wire system.

Another thing to be deprecated is the looseness of the language used by some authors. As was pointed out by a friend, it is not the current but electricity which conventionally is said to "flow along" a conductor. It would be more correct to speak of a "current *in* a conductor." Instead of talking about positive and negative electricity, or of a body as being positively or negatively charged; it would perhaps be better to speak of positive and negative electrification, and of a charged body as being in a state either of positive or negative electrification. Then one is not likely to forget the generally accepted one-fluid theory, according to which positive and negative electrification indicate respectively a state of surplus and deficit of electricity.

In speaking of magnetic fields is it not better to talk of the + or — direction *along*, not *of* the lines of force, otherwise there is the idea of their continual movement. If the ampère turn is the unit of magnetomotive force, how many lines does 1 ampère turn set up in air? In the latest work on electrical engineering, a single cell is repeatedly designated a battery.

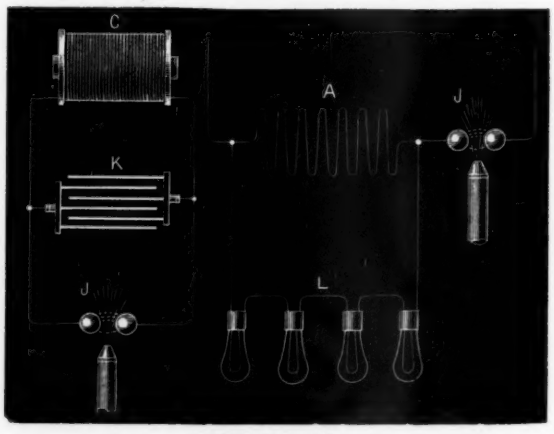
The Institution of Electrical Engineers is often called and written the *Institute* of Electrical Engineers, and occasionally one comes across the affixes M.S.T.E. and A.S.T.E. In the leading work on secondary batteries, &c., we read of Sir Wm. Thompson (Lord Kelvin), and even some friends of Thompson with a "p," write his name as "Sylvanus."

When names of great electricians are wrongly spelt, how much more carelessness and consequent error must be rampant with regard to electrotechnical terms and phrases. There is, or was, a mysterious committee on electrical nomenclature, appointed, I believe, by the Institution of Electrical Engineers before it changed its name; but of the work of that committee extremely little has transpired. It certainly could not give us a hard and fast collection of electro-technical terms, but it might, if still in existence, periodically issue lists of accepted terms with their latest definitions.

FURTHER EXPERIMENTS WITH CONDENSER, SPARK AND AIR JET.

BY ELIHU THOMSON.

IN a prior communication* I described some effects which were obtained by the induction of Leyden jar or condenser discharges passing through coils or helices upon other coils or helices placed in inductive relation with the former, and the effects of the use of an air jet or blast upon the spark discharge of a condenser as acting to enhance the inductive effects of the discharge were alluded to. It is my purpose in the present paper to still further emphasise the novel actions brought about by allowing a stream of air to play upon the discharge obtained from a condenser connected to the terminals of a high potential coil, such as a secondary whose primary is fed by alternating currents of any frequency.



FIGS. 1 AND 2.

Fig. 1 typifies this arrangement. C represents a coil which may give from 10,000 to 20,000 volts as a secondary to a suitable primary fed with alternating currents of suit-

* The *Electrical Engineer*, February 17th, 1892, also ELECTRICAL REVIEW, March 18th.

able voltage. The terminals of this coil are connected to the condenser, K, as indicated, and the discharge of this condenser is effected by means of terminals at J, and an air jet is allowed to play upon the discharge at J, for the purpose of making use of discharges of very high frequency. In other words, the inductive effects of the discharge passing across the gap, J, which, without the presence of the air jet, would be quite feeble, may be enormously enhanced, and represent in fact the passage of currents of extraordinary frequency.

Thus, in fig. 2, if a coil, A, of a few turns of heavy copper wire, even as large as a quarter of an inch in diameter and, say, 15 to 20 turns, wound to a diameter of about 6 inches, be interposed in the path of the discharge, or in series with the discharge terminals at J, the self-inductive effects of this coil are such that a number of incandescent lamps in series are lighted in shunt to it; without the air jet at J the lamps do not incandesce. This experiment shows the presence of enormous self-induction in A, as its actual resistance can be but a very small fraction of an ohm. The presence of such high self-inductive actions in A naturally suggests that it may be used as a primary and produce strong inductions in a parallel circuit. Thus, in fig. 3, if a single turn be taken around the coil, A, and an incandescent lamp, L, demanding 25 volts and two ampères of current, be connected across the terminals of the single turn, as shown, the lamp at L is lighted by the inductive effects, but this does not occur without the air jet at J.

Another demonstration of the extremely high frequency of the discharges is indicated in fig. 4, where two or three

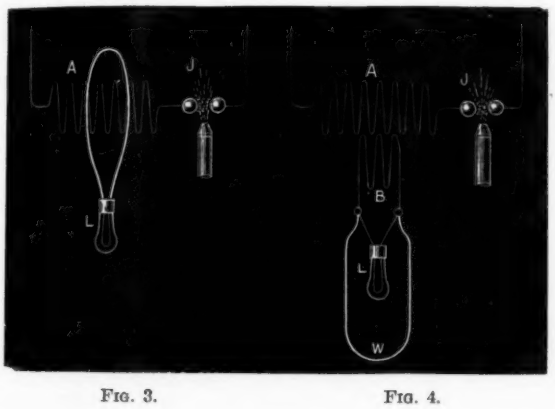


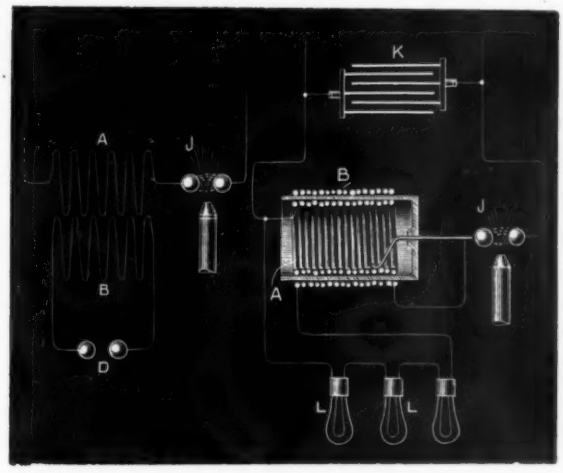
FIG. 3. FIG. 4.

turns of conductor are placed in inductive relation to the coil A, such as are indicated at B. In the figure they are indicated as being separated, but it is to be assumed that they are wrapped around the coil, A, and perfectly insulated therefrom. Several turns in B are sufficient to illuminate the lamp at L, depending upon its voltage and its resistance, even though its terminals are solidly shunted by a heavy copper wire, W, several feet in length. This experiment is somewhat similar to one of Mr. Tesla's experiments in that it depends upon the enormous frequency of the discharges in B. The effects are practically *nil* without the air jet playing at J.

If, as in fig. 5, the coils A and B be employed as a simple induction coil without an iron core, it is found that at a distance of a quarter of an inch, at J, with the air jet passing at J, very heavy thick sparks pass at D, which space may be made three-quarters of an inch in length, the sparks resembling Leyden jar discharges, although the number of turns in B is only 20, and in A about 10. Both coils are constructed of very heavy copper wire and the turns kept apart, the average diameter of the coils being six inches.

In fig. 6 is shown a modification in which the outer coil, consisting of about 20 turns of copper wire about a quarter of an inch in diameter, and the inner coil about 12 turns of somewhat similar gauge, are connected together so as to form, as it were, a closed circuit with each other through the lamps at L. The discharges are sent through the system as before by the air jet spark at J from the condenser, K, fed by high potential alternating currents of 10,000 to 20,000 volts. The lamps at L are brilliantly lighted in this experiment. Variations of the effective length of the single coil, A, which is made of bare wire, can be obtained by a sliding contact, as indicated in the figure. This contact may be made to include more or less of the turns of A.

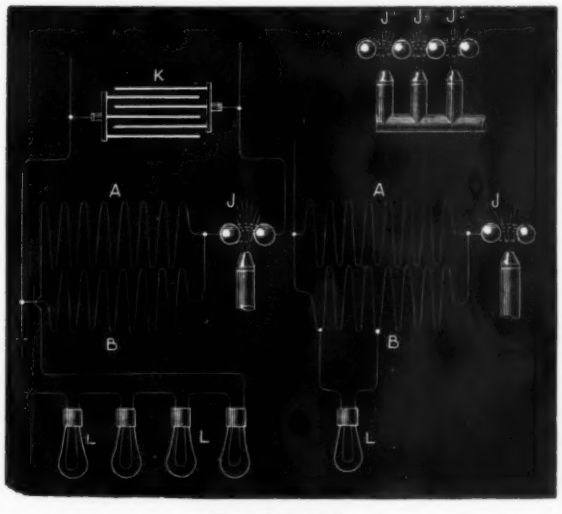
A modification of the experiment, fig. 6, is shown in fig. 7 in which two coils, A and B, are connected in multiple, but the coil, A, is connected through the lamps, which are



FIGS. 5 AND 6.

brought to high brilliancy on the passage of the discharges at J with the air jet playing thereon. The coil, B, has the greater number of turns in this experiment and probably feeds its lamps through the coil, A, by a sort of local current flowing through the two coils in series, though this is very difficult to determine. If, on the passage of the discharges across J, there are unequal inductions in the coils A and B, which set up currents local to the lamps, we would have an action analogous to the flow of currents locally to the coils connected in multiple arc when they are in unequal positions with respect to a changing magnetic field, causing an inequality of electromotive forces to exist.

Fig. 8 shows that with the coils connected in multiple,



FIGS. 7, 8 AND 9.

even though their turns be unequal, it is easy to light a lamp, L, which spans a few of the turns in the outer coil. The lamp used in this case was a 100-volt lamp. The vigour of the self-inductive actions is certainly remarkable, and with the ordinary periodicities of alternating current, namely, 125 or 250 alternations per second initially used, effects due to very high frequencies are very readily obtained. The actions appear to be more vigorous the larger the condensing surface in K, the longer the spark at J, and the more vigorous the air jet used. The air jet hitherto employed by me has been of very moderate pressure and I expect to

increase its force with the construction of a much larger apparatus for getting these inductive effects.

It would appear that we have in the air jet and the spark discharge a partial solution of the problem of obtaining very high frequencies in a fairly continuous manner. Fig. 9 shows an arrangement which may be found more effective when working with very powerful apparatus; that is, a series of spark gaps, J^1, J^2, J^3, are each of them provided with air jets blowing therethrough. A much higher potential will be required to leap these combined spark gaps while the extinguishing action or the blowing action of the jets will be equally vigorous in each space. The apparatus is so simple and of so little cost to construct even for obtaining, by inductive actions of this character, sparks of great length and extremely high voltage, that it is contemplated to construct a much larger apparatus than that which has hitherto been used.

The coil, B, in these experiments while made of a few turns of heavy, coarse wire, was in my former communication described as constructed of a much larger number of turns of fine wire immersed in oil, and it was shown that torrents of long sparks could readily be obtained therefrom. The ratio of inductions between the coils, A and B, seems to be approximately those in an ordinary transformer, and while it is very difficult to estimate from the length of spark alone the actual voltage existing, yet it is certainly true that very many thousands of volts potential difference exist between the terminals during the passage of such sparks as 7 inches and 8 inches in length. The striking distance, however, appears to increase much more rapidly than the potential, and if the law holds good it would appear to be easy to secure sparks of very great length by extending the scale of my experiments.

It may be remarked here that in reference to striking distance, it is a question whether there is not a certain potential, which, from a certain sized terminal, will strike at any distance. It would appear that in order to prevent the discharge from passing into the air, either in the form of a brush or a discharge connecting the terminals, the terminals themselves should be made in the form of larger and larger poles kept perfectly smooth the higher the potential worked with, and that for voltages as high as 200,000 or 300,000, terminals tipped with small balls would act practically as points and allow discharge into the air in the form of a brush discharge, if this potential could not actually cause a leap between the terminals.

THE ELECTRICAL UTILISATION OF WATER AND WIND POWER FIRST PROPOSED BY NOLLET IN THE YEAR 1840.

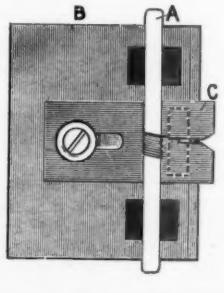
By A. M. TANNER.

It has long been an unanswered question as to who first proposed the utilisation of natural forces for generating magneto-electric currents. In the early days following the discovery of magneto-electric induction by Faraday, the machines devised by Pixii, Clarke, and others were only used or intended for laboratory or schoolroom experiments. The first to propose the idea of using magneto-electric machines for industrial purposes was Prof. Francois Nollet, of the Military School at Brussels. In his Belgian patent, dated January 6th, 1841, he shows the peculiar combination of a magneto-electric machine, electrolytic water decomposing apparatus, and gas motor. Strangely enough it did not seem to be feasible to him until the year 1851 that magneto-electric currents could be used directly for producing light, heat, and power, and he resorted to the intermediate step of converting electricity into gaseous force, and then again into mechanical force or heat and light. It is a well-known historical fact that when magneto-electric machines made by Nollet were proposed for lighting the Hotel des Invalides at Paris, more importance was at first attached to burning a gas produced by the electrolysis of water than to using the current directly for arc or incandescent lighting. This, however, was soon changed when the Alliance Company obtained control of the Nollet inventions, and its director, Berlioz, proposed dispensing with commutators in the machines employed for arc lighting; alternating currents having been found best adapted for the purpose. With this slight digression to show the connection of Prof. Nollet with the "Alliance Company" of later years the writer returns to the consideration of the Belgian patent of 1841. The drawing shows a drum armed with radially arranged peripheral armatures in which currents are induced by rotation in an outer magnetic field. As indicated in the drawing, it was the intention to decompose water by the magneto-electric current of the machine and explode the gases produced in an engine for producing motive power, and also to work the magneto-electric machine. The description, however, is most suggestive and prophetic when it states that the magneto-electric machine not only could be operated by a gas or steam engine, but by an air or water motor supplied by forces offered by nature; a motor of this kind being of no greater expense than the cost of applying it, furnishing a constant and continuous force, giving a uniform movement requiring small space, little repairs, and presenting no danger whatever. In these few words (translated almost *verbatim*) will be found the fundamental principle of all modern systems of the electrical utilisation of natural forces, because it makes no difference whether the magneto-electric current is used directly or indirectly to produce the final result. It is not apparent that Nollet had in view long distance transmission of electrical energy; but who will say that any invention was required in making the circuit between the magneto-electric machine and the translating device, short or long. As the American Courts would say in patent cases, this would be a question of degree only, not involving patentable invention. To Prof. Nollet, therefore, belongs the honour of having first proposed the employment of natural forces for operating magneto-electric machines.

SUSPENDING FIBRES.

By T. H. MURAS.

A new form of suspension for a fibre in a galvanometer was described by Mr. G. L. Addenbrooke at the Physical Society, March 10th, 1888 (Electrical Review, xxii., 290). I have found the following modification of that suspension useful, as it permits adjustment of the magnet and mirror in any direction. The channel in which the magnet and mirror is suspended extends vertically through a horizontal plate, B, fixed at the top of the instrument. This plate carries the supports for the rod and the fibre, which may be simply a glass rod, A, held in notches in two corks.



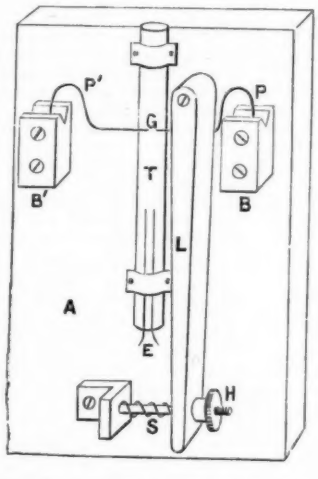
The fixed plate also carries a brass plate, C, about $\frac{1}{16}$th inch thick, which is secured by a washer and a screw passed through a slot into the fixed plate, so that it lies over the channel. A fine saw cut is made in the brass plate to receive the fibre, the outer end of the cut being enlarged to admit the fibre readily, and the inner end being cut obliquely so that the fibre hangs over it in a definite position. The screw being loose, the brass plate can be moved in any horizontal direction on the fixed plate, to adjust the position of the fibre, and it can then be fixed by tightening the screw. The mirror can, of course, be raised or lowered by turning the glass rod.

A DETECTOR FOR SPARK IN HERTZ'S RESONATOR.

Since Prof. Hertz published his classical researches on electrical oscillations, several methods have been devised for showing some of the principal experiments to a number of people simultaneously. Many of these have been rather "indirect," and hence explorers in this interesting field of research which is so full of promise for the future, will welcome a new and very direct method which has recently been worked out by Messrs. W. Lucas and T. A. Garrett.

The new method depends for its novelty upon the ignition of an explosive mixture of gases by the spark of the resonator, and a convenient form of apparatus for effecting this is described in the current issue of the *Philosophical Magazine* [Vol. xxxiii., series v., No. 202, pp. 299—301]. The following description with the lettering refers to the accompanying illustration :—

A long strip of wood (not shown), having near its ends two projecting blocks with V-cuts in them, is supported in a horizontal position, and to the middle of it is screwed the base-board, A, its position being vertical. B and B′ are two more blocks with V-cuts in them. The four blocks are arranged in such a way that the V-cuts in them are in the same straight line. In the V-cuts of the four blocks the two straight wires which form the resonator rest. The spark-gap, G, is between the ends of the platinum wires, P



and P′ ; these are led down into the V-cuts in B and B′, as shown, so that the resonator wires rest in contact with them. P is fixed firmly to the wooden lever, L, so that the size of the spark-gap can be easily adjusted by turning the milled head, H, against which the lever is pressed by the spiral spring, S. To allow for this adjustment, P is bent as shown, and P′, though fixed permanently, is also bent, so that both parts of the resonator may be symmetrical. With this arrangement, one pair of resonator wires can be very readily replaced by another pair of a different size. T is a glass tube open at the top. Its lower end is closed, and two platinum electrodes, E, are sealed into it. Two small holes are bored through it diagrammatically opposite to each other, through which the platinum wires, P and P′, can pass freely. This tube is partly filled with hydrochloric acid, and the electrodes, E, are connected with a battery so as to generate an explosive mixture of hydrogen and chlorine. If the resonator sparks when enough gas is present in the tube, an explosion is produced.

In order that an explosion may be produced by every spark, the time required for filling the tube with the necessary quantity of gas must be less than the interval of time between two sparks.

If this interval is small, the quantity of gas requisite for an explosion must be small, and it must be generated quickly. Now, in order that this quantity may be small, the diameter of the tube must be small, and the spark-gap must be near the surface of the electrolyte. It is found, however, that when under these circumstances the gas is generated quickly, an explosion very rarely takes place, owing to the fact that liquid is carried up to the spark-gap by the rush of gas, and a minute drop almost always adheres to the ends of the wires forming the spark-gap, so that no spark, and consequently no explosion, is produced. This difficulty can, however, be easily overcome by connecting the two halves of the resonator with a battery of three or four cells, so that as soon as a minute drop is formed across the spark-gap, it is at once dissipated by the current which passes through it. If the battery connections are made at nodes, the proper working of the resonator does not seem to be interfered with, so that the battery may remain in permanent connection with it.

The same battery may, of course, be used both for getting rid of the drop and for generating the explosive mixture of gases, the circuit of which is completed by the drop in the spark-gap, being a shunt on the circuit through the electrolyte. When it is desired to work with a very small spark-gap, it is found very convenient to include a rough galvanometer in the former circuit, as a small spark-gap can then be very easily made by screwing up H, stopping directly a deflection is obtained, and then screwing H back very slightly, so as to just break the circuit.

Very satisfactory results can be obtained with a tube of 16 cm. in length to 8 mm. inner diameter, the spark-gap being about 5 cm. from the top.

THE TELEPHONE QUESTION.

In moving that the New Telephone Company's Bill be read "this day six months," Sir James Fergusson stated that it was the intention of the Government to bring in a Bill of their own dealing with the subject, and briefly outlined some of the proposals they would bring forward. Some concessions are contemplated, as will be found in our verbatim report. These concessions are to be hedged round with reservations, in order that the Government monopoly of telegraph communication may be sufficiently maintained, and the telegraphic revenues prevented from suffering a loss. Until the full details are before the House it is evident that no complete criticism can be offered of the Government proposals, but we fear that the outline which was given of them by the Postmaster-General must be considered to be disappointing. He remarked that the policy of the Post Office was that the public should have the benefit of competition, and licenses were given to several companies ; but the policy of the companies has been to amalgamate, and Sir James Fergusson is of opinion that in consequence of that amalgamation, the benefits which the Post Office contemplated from competition have not been obtained. In pursuance of their policy, therefore, the Post Office will license substantial persons to carry on a telephone business within any area in which the local authorities consider that further telephonic facilities are desirable. The licenses will be limited apparently to a definite local area, and the Government propose to retain in their own hands not only trunk communication between town and town, but also between separate exchanges in one town. Whatever may be the opinion in regard to this policy as a general commercial one, we do not hesitate to say that its application to telephonic communication is a mistake, and it would seem to indicate that the Government overlook the difficulties of the case. A little experience of such a system will show that divided authority between one telephonic correspondent and another telephonic correspondent will lead not to the improvement of telephonic communication, but to troubles, delays, and general inefficiency, even if the central authority determine all the details. It will naturally occur to ask whether, as the Government control the trunk lines, they will make it compulsory on the part of one company in one town to permit communication from one of its subscribers to another subscriber on another company's exchange in another town. This will involve, not only the question of whether it is fair to give one organisation facilities which have been earned by another organisation, but it will also imply that the systems adopted by both companies shall permit such intercommunication. In the present stage of the telephonic industry, it is inevitable that divers views

should exist as to what is the best system to be adopted, and it may be taken for granted that that which is considered good by one may be considered bad by another, and in the smallest details there is room for much trouble arising, so that the advantage to the public of the Government proposals may be deferred until such time as the inconvenience resulting from divided authority shows the necessity for a complete control of the whole telephonic system by one body. Sir James Fergusson does not seem to grasp the fact that telephonic amalgamations are governed by a natural law other than the efforts of the companies to take care of themselves. Wide experience has shown in divers places that opposing exchanges in the same area prove to the public and the suppliers the advantages of intercommunication, and, consequently, combination. As this has already been proved before, so we have no doubt it will be proved again, it is therefore to be regretted that the Government did not see their way to settle the question now and for all instead of making partial efforts to obtain advantages which will certainly be deferred, and in the meantime the convenience of the public will suffer. A bold policy either of permitting unlimited competition, subject to royalties, or of entirely Government control might have been commended. The middle course which the Postmaster-General has outlined can only be described as a policy of "meddling and muddling."

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AUTHORISED ABSTRACT OF DISCUSSION ON PROF. HUGHES'S PAPER ON MARCH 17th, 1892.

Mr. CAMPBELL SWINTON said he had made some experiments on the difference of sparking distance in air and in oils; his results did not agree with those of Prof. Hughes, but made oil much worse. He used as a source of E.M.F. an induction coil capable of giving a 7 inch spark in air, the distance he found from one to three times as long in air as in oil. Possibly his oils were not of so good a quality as Prof. Hughes's. He would like to know if Prof. Hughes dried his oil. He had tried doing this but found that after drying it would re-absorb water and therefore preferred tests on undried samples as being of more practical value. When using paraffin oil he found a distinct deposit of carbon at each discharge.

Mr. JOHNSON (of Johnson and Phillips) rather objected to the claim to have anticipated Brooks's system. Prof. Hughes's system was one with an insulated pipe (G.P., &c.), Mr. Willoughby Smith had tried it and found it of little use. He objected also to the idea of the oil closing up faults in the G.P. covering of a cable on the same principle that it was bad to use tarred yarn on G.P. core, it temporarily closed incipient faults and thus prevented their detection. His firm had a line laid at their works on the Brooks system which had been repeatedly tested at 15,000 volts and had stood it perfectly. There was a great difficulty in getting the right quality of oil. The best method of testing he thought was to pass it all through a narrow orifice and test it electrically as it passed.

Mr. GRAY called attention to a paper by Rousseau in 1826, (?) on the insulation resistance of oils. He himself had made some tests on specific resistance by direct deflection with 100 cells, his results were as follows in C.G.S. units $\times 10^{20}$. Rape oil ·5 to 5, lard oil 2·2 to 5, colza 1 to 15, cotton seed oil 53 and linseed ·31 to ·8; he then measured the spark distance with 10,000 volts and took the resistance again, which was always less than before with vegetable oils and paraffin. With thick rosin oil he found when the electrodes approached to such a distance that 10,000 volts once gave a spark, that 2,000 volts would then give a spark through the same distance. Having measured some rosin oil in 1887 with 100 cells, he found in 1889 a higher specific resistance with 25 cells but a lower one when measured with 100 cells as before.

Mr. VARLEY preferred to test the air and oil in series, instead of parallel as Prof. Hughes did, *i.e.*, he put one electrode under oil and the other some distance above it. He had tried to make a condenser with three thicknesses of bank post paper between the plates, immersing it in dried paraffin, but it broke down at from 300 to 400 volts.

Dr. FLEMING said that no one need be afraid of putting transformers in oil, as Rhumkorf had used it for insulating his coils in 1851. A description was also given by M. Gine (? Jean) in 1854 of a coil wound in cotton covered wire, which was dessicated in vacuo and then kept under turpentine oil, from this he got a 12-inch spark. A paper by Poggendorf on the same subject would be found in *Phil. Mag.*, July, 1855, using vegetable oil or oil of turpentine. He would suggest, on the analogy of alloys having a higher specific resistance than pure metal, that perhaps some mixture of two or more oils might be found which would give higher insulation than pure ones.

Mr. DONOVAN asked why the Post Office did not take up oil insulators, and wished to know how many miles of oil insulated cable were now in use. He said that if vegetable oil were mixed with paraffin, the latter would evaporate and leave the vegetable oil behind.

Mr. CUTHBERT HALL had found that the temperature coefficient of oils was very high, the resistance varying as much as 20 per cent. between 16° and 24°. The best insulating oil he considered to be half of "first run" oil and half of solid rosin. He had found jute to be a very good insulator; the insulation of a dry jute covered cable was actually lowered by impregnation with oil. Transformers he preferred to slowly heat up to a high temperature, then immerse in rosin oil. He confirmed Mr. Gray's experience of continuous sparking in paraffin when the first spark had passed, but rosin oil did not behave in the same way.

The PRESIDENT said there had been a good deal of loose expression with regard to the resistance of the various oils. "High resistance" had been used by different speakers to mean: 1. Actual high specific resistance in the same way that one speaks of the specific resistance of a metal. 2. High resistance to a spark passing through the mass of the oil; and 3. High resistance of the surface of the film. Which of these was Mr. Hall referring to when he mentioned the high temperature coefficient.

Mr. HALL said he measured the actual resistance between two metal plates wholly immersed in the oil and therefore referred to the first meaning.

Mr. KAPP said the first transformer he tried to insulate with oil broke down in two or three minutes. It was wound with silk covered wire. He then had the coil unwound and the wire rewound, after passing through a bath of boiling paraffin on its way to the winder. The transformer then ran with 17,000 volts and had never broken down again.

Mr. TROTTER asked what was the real weak point in an oil cable—was it the oil itself or was it the solid insulator, hemp, paper, or G.P.?

Prof. FORBES said that just at first cables were insulated with G.P., as at Paddington. This was soon given up because the wires were run so hot that the G.P. got very soft. To-day, however, cables were never run hot, and he thought it quite possible that G.P. might be tried again with good results. He also thought that something should be done to try and improve G.P. by treatment with oil.

Mr. PREECE said Mr. Donovan had asked why the G.P.O. did not use oil insulators and Brooks cables. The objections to the former in England were that the rain got under the oil (light oil having been used in those he tried), that the wind blew the oil out, and that spiders could not be kept from spinning their webs over them. He had been much impressed with Mr. Brooks's system when he first saw it and had a 40-wire line put down from Vauxhall to Clapham Junction. They had considerable trouble at first with bad joints in the tubes, but even when these were put right the water got in when they were using light oils, of which very large quantities were lost. He then got some special heavy oil from America, but could not get it to run far along the pipes. However, the wires still tested well even when the oil had more or less leaked away, and they were only separated by impregnated cotton or hemp, say 1 Ω per mile. This was quite good enough for practical work, and was steady; and a great improvement over an air line, which might test 100,000$^{\omega}$ a mile one day, and as many megohms on another.

Mr. SWINBURNE said the "healing" property of oil insulation did not exist for transformers. When a coil once sparked across it was ruined. In a transformer there were many horse-power behind the spark, and when it passed an arc at once followed it. He had tried drying the oil chemically in various ways, but had found it quite useless. The real insulator he considered to be dry celulose, the oil merely keeping the moisture out. Perfectly dry cotton even when thoroughly saturated with oil will get moisture from the atmosphere if exposed to it for a short time. When jointing impregnated cables three or four feet should be cut off each of the ends, and the joint made at once. The oil for insulating transformers must be heavier than water, or moisture will get down, and if it touches the covering of the wire at any point it will spread all over it.

Mr. JOHNSON, referring to Mr. Preece's remarks about oil insulators, said that in the line on which they were tried by the Post Office, he himself had counted some six or seven common shackle insulators, and that the end of the line was connected to a quarter of a mile of old gutta-percha cable in an underground pipe. This he thought was quite enough to account for the poor results obtained.

Prof. HUGHES in reply, said that the high results which he gave were the best he could get. The very high ones were for sparking distance with the "impulsive rush," working with Leyden jars. He found the rosin oil of to day not nearly so good as that which he used in his earlier experiments. With regard to the Brooks's system, he liked Mr. Brooks when he brought his system over, and said nothing about his own previous work in the same direction. He noticed, however, that Mr. Brooks had disclaimed a good many things in his patents, and now relied principally on the use of standpipes and on heating the oil. In reply to Mr. Trotter, he never found any covering equal to gutta-percha in resistance. He agreed with Prof. Forbes that gutta-percha might be much improved by oil treatment.

Mr. CAMPBELL SWINTON, referring to Mr. Swinburne's remarks, pointed out that Mr. Tesla said his transformer constantly broke down and "healed" itself.

Mr. SWINBURNE replied that Mr. Tesla was only dealing with infinitesimal currents of small power. In ordinary commercial transformers the fact was as he had stated—there was no healing power.

LOAD DIAGRAMS OF ELECTRIC TRAMWAYS, AND THE COST OF ELECTRIC TRACTION.* By A. RECKENZAUN, Member.

IN the present paper I propose to draw attention to two important branches of this rapidly-growing subject, "electric traction." These branches relate to the energy consumed in propelling electric cars, and the commercial results of several tramways in different parts of the world.

* Paper announced to be read March 24th, 1892.

Of the errors into which the pioneers in electric traction fell, none was more serious, and I may say more general, than that of providing insufficient motive power. The early motors were all too small, too lightly built, and consequently were not durable. In spur gearing, the double-reduction gear has been abandoned by the principal American firms on account of its great cost of maintenance; the high speed at which the motor pinion had to run was detrimental to the life of the mechanism. A reaction has set in, and attempts are being made to drive cars by placing the armatures directly upon the axle. It is questionable whether this method will prove successful in the long run. But the single-reduction gear—that is to say, one pinion and one spur wheel running at moderate speeds—appears to give excellent results, and the repair bills have been largely reduced in consequence.

If we calculate from the accepted coefficients of resistance to traction on commom tram rails, we find that an ordinary tramcar will require but 3 to 4 H.P. for its propulsion when once in motion. But it is the setting of a vehicle in motion from a state of rest which demands the greatest amount of energy, and the electric motors which were built in the early days were soon knocked to pieces by

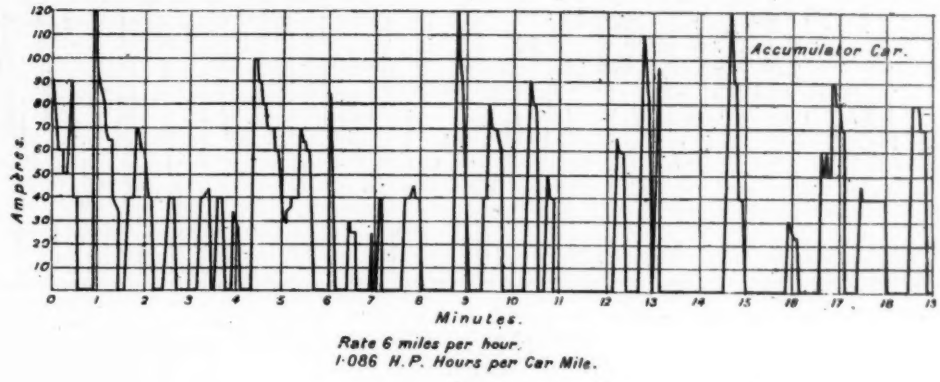


FIG. 1.

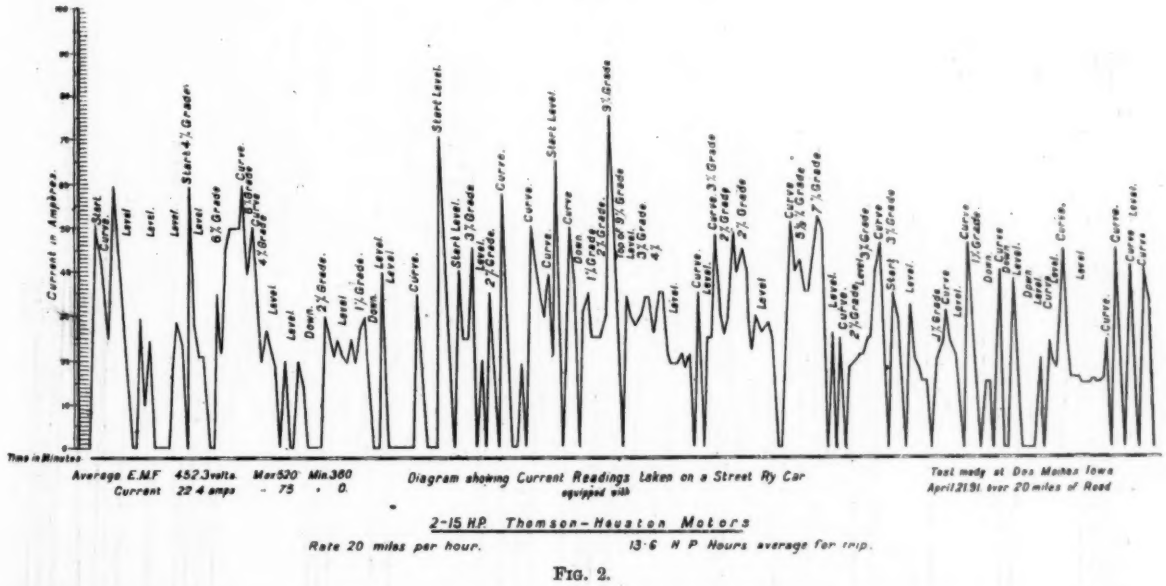

Current in Ampres.
Time in Minutes
Average E.M.F 452.3volts. Max 520 Min 360
Current 22·4 amps " 75 " 0.
Diagram showing Current Readings taken on a Street Ry Car equipped with
Test made at Des Moines Iowa April 21 91. over 20 miles of Road
2-15 HP Thomson-Houston Motors
Rate 20 miles per hour.
13·6 H P Hours average for trip.

FIG. 2.

consumed, we find it to be 31 ampères. The maximum E.M.F. was 160 volts, and the mean 157 volts, giving an average of 6·52 electrical H.P. used by the car motor. The maximum current of 120 ampères into the minimum E.M.F. of 140 volts would give 22·5 electrical H.P., but this occurred only nine times during the journey, and each time but for a second or two. Currents of from 60 to 100 ampères were recorded more frequently.

The next three diagrams are exceedingly interesting, as they represent the working of three different systems of electric cars on an overhead conductor line at Des Moines, U.S.A. These tests were made on the same day, over the same length of track, with the same number of passengers carried, and the same kind of car body. The cars were operated by the same man, and the readings were taken by officials of the tramway company.

Fig. 2 was obtained from the car fitted with two 15 H.P. Thomson-Houston motors. The maximum current at any time was 75 ampères, the mean 22·4, dropping at times to zero, while the E.M.F. varied between 360 and 520 volts on a run of 20 miles.

Fig. 3 gives the curves from observations on a car propelled over the same distance by means of two 15 H.P. Sprague motors. Here

the enormous strain put upon them on starting. On English tramways, it has been computed, a tramcar has to stop from four to eight times every mile, according to the amount of passenger traffic. With a view of ascertaining the exact conditions as to the variations in the power consumed on an electric car, I made a series of tests four years ago with an electric car in the public streets of Philadelphia. Fig. 1 represents a portion of a diagram obtained from careful readings with reliable instruments. The whole trip lasted 71 minutes, but the diagram (fig. 1) represents only the first 19 minutes. Readings were taken and recorded every three seconds. The maximum current, it will be observed, reached at times 120 ampères. This occurred when starting on curves and gradients. Frequently it dropped to zero, and, in fact, these gaps, representing periods when no current was used, gave, on being added up, 45 per cent. of the total. The car contained 84 storage cells weighing 3,400 lbs., and it carried an average of 26 passengers. The aggregate weight propelled was 7 tons. The distance covered during the entire journey was 7 miles, giving a mean speed of only 6 miles per hour, and this had to be maintained on account of the horse cars which ran on the same line. Averaging the current again we observe a maximum current of 75 ampères, average 25·95 ampères, with E.M.Fs. varying from 320 to 560 volts at the motor terminals.

Tests represented by Fig. 4 gave the following results with two 15 H.P. Westinghouse motors:—Maximum current, 95 ampères; mean, 31·3 ampères; maximum E.M.F., 560; minimum, 380.

I could give more diagrams of a similar kind, but these will suffice for the purpose of showing the enormous and remarkably frequent fluctuations of current, and the attendant rise and fall of the energy consumed. With several such cars running on a line, with overhead or other conducting medium for the transmission of electricity from the generating station to the moving cars, the peaks would occur at more frequent intervals, filling the great gaps in proportion to the number of cars running simultaneously. Little reliance, however, should be placed upon the possibility of obtaining even a moderately constant load at the generating station. From numerous experiments, I have found that it takes about 20 seconds to bring a tramcar from rest to its normal speed; during this period the current drops gradually from its maximum, due to the ohmic resistance of the circuit, to a value corresponding with the load upon

the car motor at its normal speed. The stoppages on tram lines with much traffic are so numerous, that it will often happen that a large percentage of the cars start simultaneously, when for a moment the engines and dynamos have to exert their utmost power, and before the engine governor has time to act, the current may be down again at, or below, its normal.

I am indebted to Mr. Gibson Carey, of the Thomson-Houston Company, for the diagram (fig. 5) which represents the fluctuations of the load at the generating station at the Roundhay electric tramway at Leeds. Five cars were simultaneously on the line, yet the generating station, amounts in some cases to only 25 per cent., and that in no case does it reach over 40 per cent. in everyday practice on a tram line. With electric railways having fixed stopping places at long intervals, with the time-tables so arranged that only on rare occasions several trains start simultaneously, a higher efficiency may be aimed at.

Electric light engineers will look with amazement, and perhaps envy, upon the variations in the voltage marked on figs. 2, 3, and 4. But these are exceptionally great fluctuations, and there are many electric tramways where the volts do not vary more than 15 per cent.

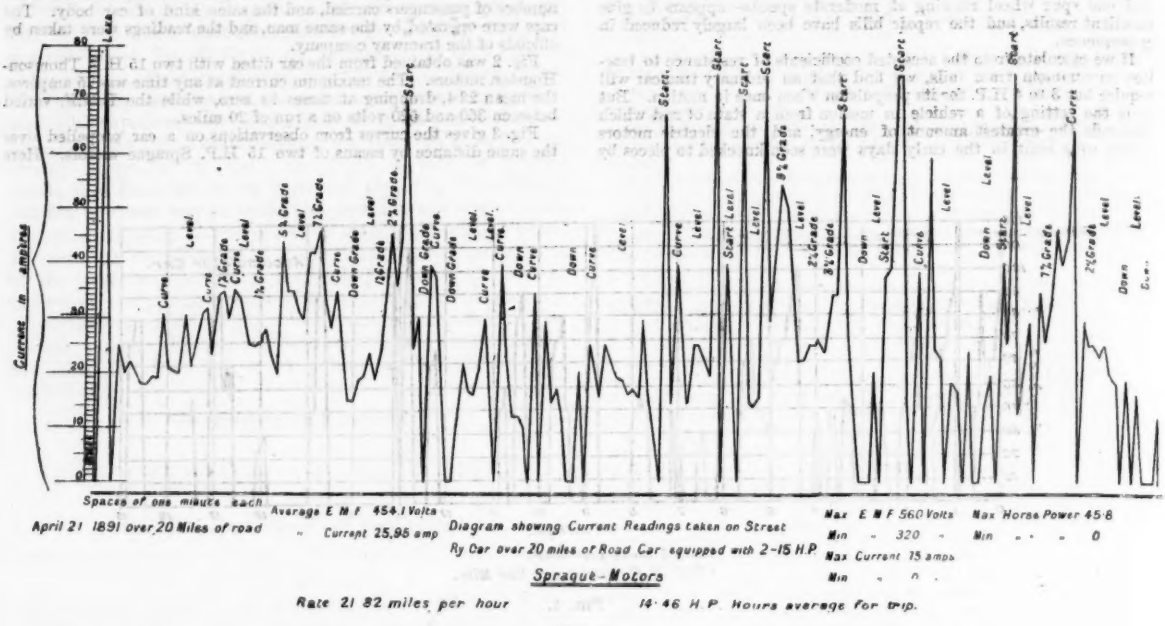

Current in amps
Spaces of one minute each
Average E M F 454·1 Volts
" Current 25.95 amp
April 21 1891 over 20 Miles of road
Diagram showing Current Readings taken on Street Ry Car over 20 miles of Road Car equipped with 2-15 H.P. Sprague-Motors
Max E M F 560 Volts
Min " 320 "
Max Current 75 amps
Min " 0 "
Max Horse Power 45·8
Min " " 0
Rate 21·82 miles per hour
14·46 H P Hours average for trip

FIG. 3.

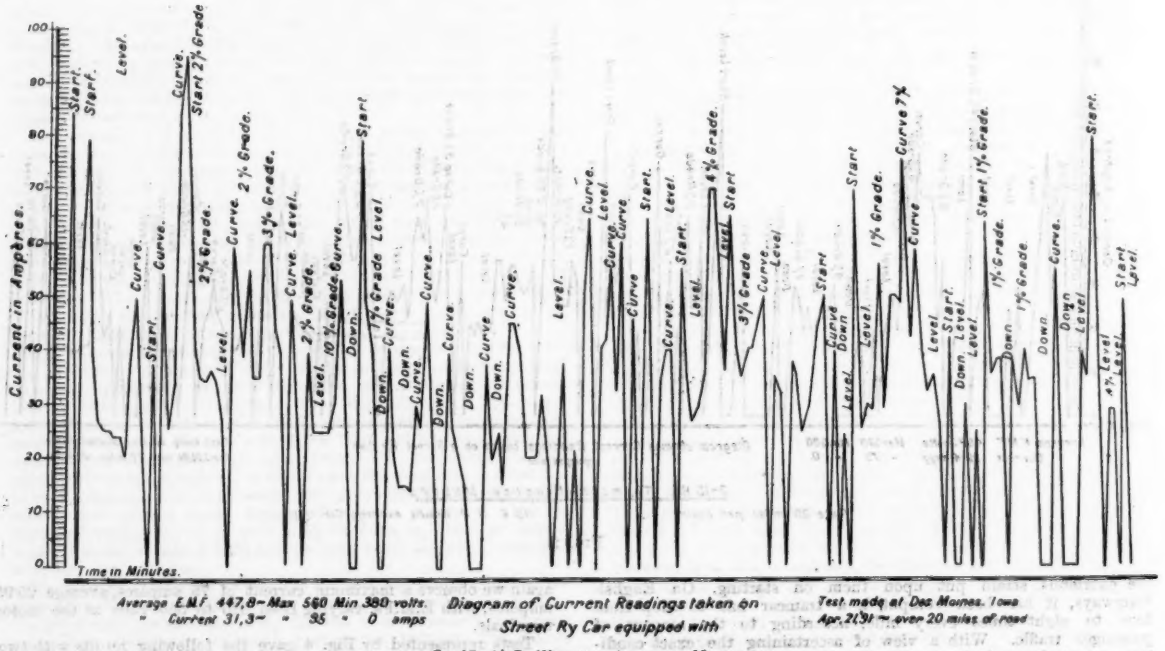

Current in Amperes.
Time in Minutes.
Average E.M.F. 447,8-Max 560 Min 380 volts.
" Current 31,3- " 35 " 0 amps
Diagram of Current Readings taken on Street Ry Car equipped with 2-15 H.P. Westinghouse-Motors.
Test made at Des Moines, Iowa Apr. 21/91 — over 20 miles of road
Rate 24·49 miles per hour.
15·49 Hours average for trip

FIG. 4.

current dropped to zero 20 times within the space of one hour. These abrupt changes have the effect of reducing the average efficiency of the whole system to a comparatively low figure. The engine and dynamo must be able to furnish the maximum energy demanded at any instant, whilst the mean power in many cases scarcely comes to one-third of the maximum. Measurements made by Dr. Louis Bell on several American electric tramways have shown that the efficiency of an entire system, taking the brake horse-power of the car motors, divided by the indicated horse-power of the engine at the

A sudden call for large currents always lowers the potential, and this is partly due to the feeders being proportioned to the average output, and partly to the momentary slowing down of the engine. When the governor begins to act, the excess load has very often already disappeared, and then there is a tendency to racing for the next moment, and a simultaneous rise of E.M.F. above the normal. At the City and South London Electric Railway, which is only 3½ miles in length, the deflections on the voltmeter vary between 370 and 500, notwithstanding compound-wound generators, and a regular schedule time of

running the trains. Several years ago I suggested a remedy for equalising to some extent the load upon the generating plant of an electric tramway with overhead conductors, but my suggestion has not been adopted. I advised the use of secondary batteries to act as regulators—not batteries of large capacity, but such as would give a very high discharge rate. Plain lead plates of very large surface, formed on the Planté or any similar process, would certainly add to the smooth working of any railway or tramway where great fluctuations of load are unavoidable, and compound-winding insufficient. An accumulator of this description could be made very cheaply, and by allowing sufficient material it can be of any durability desired. The diagrams show that the large excess of current is only required for a few seconds at a time, therefore a storage battery of large surface would furnish this in a far more rational way than the best designed dynamo worked by the most delicately governed steam engine. It would save engine power, and reduces the chances of breakdowns due to sudden shocks to the generating plant.

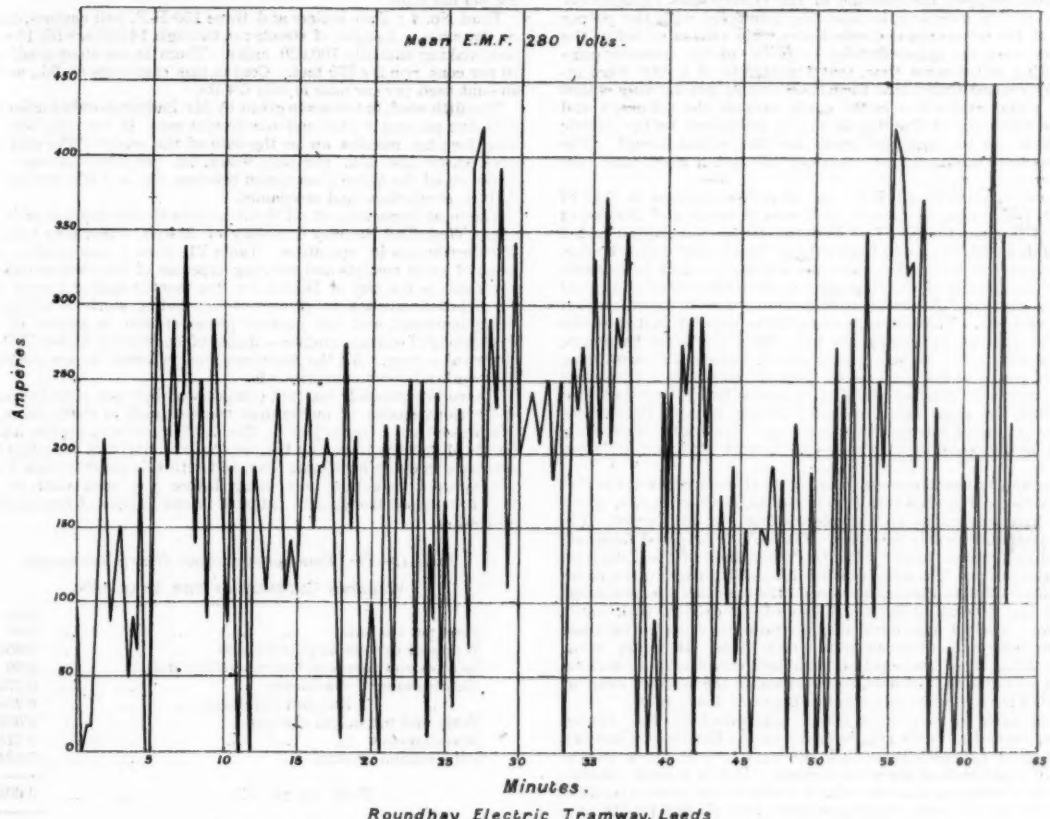
Again reverting to our diagrams, which to the practised eye reveal a number of interesting points, we find that on starting a single car, from 20 to 50 electrical H.P. are absorbed, and this occurs just when the motor is giving a comparatively small mechanical power at its minimum efficiency; this energy is absorbed in producing the initial statical pull which must be created by many ampère-turns. Now, in order to get many ampère-turns without excessive currents, I designed, some eight years ago, a switch which throws the motors in series when starting, and in parallel (when two or more motors are used) when a sufficient counter E.M.F. is created by virtue of a certain speed. I also sub-divided the field magnet coils, in order to obtain several graduations and regulate the fields to the requirements of the load and speed. Up to that time electric engineers used idle resistances for varying the speed and power. Mr. Sprague and others have adopted a similar method of regulation. The Thomson-Houston Company use resistance coils up to a certain point, after which portions of the divided field coils are thrown out of circuit. By a judicious arrangement of field windings to suit the exigencies of a given road, a very fair all-round motor efficiency can be obtained.

The battery car from which diagram fig. 1 was obtained, required for its propulsion 1·086 electrical H.P. hours per mile run, with an average load of 7 tons over a line having no gradient above 4 per cent. The figures obtained by Mr. O. T. Crosby on three American lines with overhead conductors accord with the above very closely. Thus, on the Richmond line the readings were 1·18 H.P. hours per car mile, at Cleveland 0·9, and at Scranton 0·94 H.P. hours. These cars were very much lighter than the one driven by accumulators, but there is a gradient of 9 per cent. at Richmond, and one of 7 per cent. at Scranton, while the Cleveland line is tolerably level; the speed at Cleveland averaged 9 miles per hour, and at the other two lines 6 miles per hour. The coal consumption measured at the generating stations came out as follows:—For the Cleveland line, 8 lbs. per car mile; and at Scranton, 5·6 lbs.; that of Richmond could not be ascertained, as the same boilers were used for both the tram line and the electric lighting plant.

On the Frankfort-Offenbach Tramway, and on the Mödling line, near Vienna, both built by Messrs. Siemens & Halske, the coal consumption varies between 7 and 8 lbs. per car mile. Unfortunately, I have not been able to ascertain the evaporative quality of the coals used in these places.

Mr. J. S. Badger, in a highly interesting recent communication, relates that the very best station performance he met with in the United States was 1 electrical H.P. for 5 lbs. of slack coal evaporating 7½ lbs. of water. Writing on the consumption of fuel in general on a number of American tram lines, he found that it varied between 4·3 lbs. to 12·2 lbs. per car mile, according to the quality of fuel and the nature of the road and load. Many of the American tramways have recently adopted large cars up to 25 feet in length inside, whereas the usual standard type of car is only 16 feet, carrying a proportionately smaller number of passengers, although I have frequently seen 70 passengers occupying a 16-foot car intended to seat 22 people. Overcrowding is not allowed on English tramways.

I have collected a very large amount of material with regard to the all-important question of operating expense, and I am greatly indebted for information given by Mr. Alexander Siemens, Dr. E. Hopkinson, Mr. Holroyd Smith, the Allgemeine Elektricitäts-Gesellschaft, Mr. J. S. Badger, and Mr. Robert W. Blackwell.



Roundhay Electric Tramway, Leeds
Ampère Readings at Generating Station with 5 Cars on the Road.

FIG. 5.

Full tabulated statements are appended: to read the same would occupy more time than is at our disposal; moreover, it would add to the monotony of an already very dry paper. With your permission, I will only make such observations regarding each table as may render some assistance to the study of them.

Due regard should be taken, in each of the lines, to local conditions. In Germany, for instance, the wages which form the principal item in the operating costs, are about one-half those paid in the United States. Wages and salaries in England take an intermediate position. Again, the cost of fuel varies in almost every city in the world.

One of the oldest electric tramways in the world is that of Frankfort and Offenbach, in Germany. It was built by Messrs. Siemens and Halske, and opened to the public in April, 1884. Table I. shows the detailed working expenses for the year 1890, giving the sum of 4·608 pence per car mile, including all charges. The first financial year—1884-85—gave a much higher figure, namely, 8·256 pence per car mile; and it is interesting to note that the working expenses were reduced year after year: this was largely due to improved appliances and the consequent reduction in the maintenance items, as well as in wages. The expenses of the other tramways in the city of Frankfort (which are worked with horses) for the year 1890 amounted to 9·022 pence per car mile, or nearly double that of the electric line. The slotted-tube overhead-conductor system is used here, and the entire

rolling stock consists of only 14 cars—10 of which are fitted with electric motors, serving as tow cars—holding 24 passengers each. About 1,050,000 passengers are carried per annum; this is considered a very low figure, and is partly due to the competition of a local railway. In consequence of this small traffic, the ratio between expenditure and revenue is as high as 70 per cent., notwithstanding the moderate traction costs.

A more recent and equally interesting example of electric tramway enterprise in Germany is that of the city of Halle. The cars on this line were originally drawn by horses, but a year ago the municipal authorities gave permission to the Allgemeine Elektricitäts Gesellschaft to erect overhead conductors on the plan adopted by Mr. Sprague in America. I am indebted to Mr. Emil Rathenau for a detailed statement of working expenses ranging over six months—from July 1st until the end of December, 1891. Table II. gives the averages per month and per car mile. The general expenses include taxes, municipal charges, and water rates. The water is obtained from the town supply, the sinking of a well having been found impracticable. The rolling stock consists of 25 cars; the average number actually running was 20·55. They carry drivers, but no conductors, and this fact renders the wages account remarkably low, the entire working expenses coming to only 2·624 pence per car mile, or 54·5 per cent. of the gross revenue. It must be observed, however, that no allowance has been made for depreciation, which, if included, would add nearly another penny per car mile to the expenses account. Incidentally it may here be mentioned that the Imperial German Government stopped the running of the electric cars immediately after the opening ceremony, because they interfered with the proper working of the telegraphs and telephones. The case came before the law courts, when the judges decided in favour of the tramway company, stating, at the same time, that the streets of a city were intended for general traffic, that their course could not be altered, but that the postal authorities could easily arrange the telegraph and telephone wires so that they should not be influenced by the electric lines, which use the rails and earth for the return circuit. The alterations were made, and the tramway has had a good time ever since.

The most remarkable of European electric tramways is that of Budapest, which was constructed by Messrs. Siemens and Halske, of Berlin. A few months ago I visited the Hungarian capital, and I was delighted with the perfect working of the electric cars. Underground conductors are used in this case, and the conduit is immediately underneath one of the tram rails, so that there is no additional slot in the roadway. About 50 electric cars are now in operation over 20 miles of track. The system is exceedingly popular, and it carries a larger number of passengers per mile than the horse tramways. This is probably due to the greater speed, the electric cars being allowed to run 11 miles per hour in some of the streets. I have not been able to obtain detailed working expenses, but I have been informed that the same never exceeded 50 per cent. of the revenue since the opening of the line two years ago. The ratio of working expenses and revenue on the horse-car lines at Budapest is 72 per cent.

Another among the numerous Continental electric tramways is that running between Florence and Fiesole, a distance of 4·5 miles, which was the first continuous steep-grade electric line in Europe. The Sprague system is used in this case. Table IV. is prepared from data contained in a recent paper by Mr. C. P. Sheibner, of the Istitution of Civil Engineers. The author of this interesting paper gives, under the heading, "Motive Power," the sum of the expenses arising through wages at the generating station, wages of car drivers, fuel, water, repairs, &c. These I have divided in my table in order to facilitate references with data obtained from other lines. It would be an excellent thing if all the electric tramways would keep an uniform record of all the details of working expenses, in the manner done by the existing horse tramways under the Board of Trade rules.

Coming, now, to electric traction enterprises in the United Kingdom, we find in Table III., referring to the Blackpool Tramway, that the gross expenses amounted last year to 9·91 pence per car mile, or 57·8 per cent. of the gross receipts. This is a most satisfactory result, considering that the winter traffic of this seaside resort is only just sufficient to cover operating costs, and all the profits have to be carned during the holiday seasons. This is the only line in England, and the oldest line in the world, worked with underground conductors in a slotted conduit. The rent charged by the Blackpool Corporation for the use of the line forms a considerable item—1·773 pence per car mile—in the sum of the working expenses. Directors' fees and secretarial charges also seem to be liberally arranged, making 1·187 pence per mile.

On the Bessbrook-Newry Tramway, where water power is used for driving the generators, the haulage costs during six months ending December 31st, 1890, amounted to 3·97 pence per train mile. This includes water rent, rental of buildings; wages of driver, guard, and dynamo attendant; maintenance and repairs to dynamos and conductor; oil, tallow, and waste. During the period stated the train mileage was 10,400; the number of passengers, 50,800; and goods carried, 8,600 tons.

The Americans, as you are well aware, are far ahead of us in matters relating to tramways; they count their electric roads by hundreds, and their electric cars by thousands. I need not enlarge here upon figures well known to all readers of engineering literature, but I venture to point to recent statistics on working expenses, and especially to those prepared by Mr. J. S. Badger for the Street Railway Convention, last October, when meeting at Pittsburgh. Mr. Badger gave an immense amount of data, all systematically arranged, of which Table V. is an abstract, converted into English equivalents as to money values. Those interested in all its details will find a reprint of this elaborate communication in the *Electrical World* of October 31st, 1891. Indeed, in order to fully appreciate the data contained in Table V., certain descriptive matter should accompany it, and this deals with the numbers and sizes of boilers, engines, dynamos, the quality and price of coals, condition of road and track, sizes and number of cars, total mileage, and wages in various localities. I merely give the most essential ones.

Road No. 1 has a generating station containing four boilers, one 250 H.P. Corliss engine, one 150 H.P. Ball engine, one 150 H.P. Brown engine, and two Edison generators. The line runs through five miles of streets, and the steepest gradient is 13·2 per cent., 100 feet long. There are 36 motor cars of the ordinary size, of which 20 are in daily use, making annually 601,966 miles. The price of coal is 8s. 4d. per ton, and the consumption 7 lbs. per car mile.

Road No. 2: Four boilers, two Taylor-Beck engines of 125 H.P. each, one of 175 H.P., one Armington & Sims of 250 H.-P.: five Edison dynamos. Track, 6 miles long; steepest gradient, 9·25 per cent. for 400 feet. 18 motor cars, of which 16 are in daily use, making an annual mileage of 724,000. Price of coal 7s. 3d. per ton; consumption, 11 lbs. per car mile.

Road No. 3: Eight boilers; nine steam engines, of which five are of 125 H.P. and two 100 H.P., all of the Phœnix type; also two 125 H.P. Beck engines. Nine Edison and seven Thomson-Houston dynamos supply current for 50 motor cars in daily use, making an average of 1,819,000 miles per annum. There are altogether 53 motor cars, of which four were supplied by Westinghouse, 20 by Edison, and 29 by the Thomson-Houston Company. Steepest grade, 8 per cent. for 800 feet; total length of streets traversed, 35 miles. Cost of coal, 11s. 2d.; and the consumption of fuel is calculated to be 12·2 lbs. per car mile.

Road No. 4: Two boilers and three 150-H.P. ball engines, driving six dynamos. Length of streets run through, 14 miles, with 18 motor cars, making annually 700,000 miles. There is one steep gradient of 10 per cent. rise for 775 feet. Coal in this case costs 8s. 9d., and the amount used per car mile is only 6·4 lbs.

The fifth road, out of seven given by Mr. Badger, is only 4 miles long, with five passenger cars and one freight car. It has only been running for nine months up to the date of the report. The coal costs 12s. 8d. to 15s. 10d. per ton; water, 5d. per 1,000 gallons. The wages on all the above lines varied between 40s. and 60s. per week for drivers, conductors, and mechanics.

The most important of all the American electric tramways is that of the West End Railway Company of Boston, where they have now 400 electric cars in operation. Table VI. gives a comparative statement of gross receipts and working expenses of the electric cars and horse cars in the city of Boston for five months ending August, 1891. No detailed account is given, but the rolling stock is continually being increased, and the central power station in course of construction will contain engines capable of converting 12,000 H.P. into electrical energy. All the American lines referred to are worked on the overhead conductor principle.

I have intentionally omitted comparisons between electric traction and various modes of mechanical traction, such as cable, steam, and compressed air. Our object in this Institution is to inquire into the merits of systems involving the use of electricity, and to further their extension in every legitimate way, and with this point in view I have endeavoured to collect and bring before you such data as may tend to increase the general interest in one important branch of our profession.

Table I.—The Frankfort-Offenbach Electric Tramways.

WORKING EXPENSES OF THE YEAR 1890.

	Pence.
Fuel, per car mile	0·48
Wages of drivers and conductors	0·864
Salaries and wages at the generating station	0·96
Maintenance of machinery	0·576
" " line and buildings	0·288
Taxes and municipal charges	0·058
Miscellaneous	0·518
Depreciation account	0·864
Total per car mile	4·608

Table II.—The Halle Electric Tramways.

WORKING EXPENSES FOR SIX MONTHS ENDING DECEMBER, 1891.

Average number of cars running	20·55
Total car miles for six months	266,796
Average number of car miles per month	44,466
" " " " day	1,449·3
Daily average mileage for each day, per car	70·6
Total gross receipts for six months	£5,354 8s.
Average gross receipts per month	£892 8s.

WORKING EXPENSES.

	Pence.
Coals	0·3980
Waste, oil, and cleaning materials	0·1444
Wages and salaries	1·4430
General expenses	0·3930
Life insurances	0·0216
Maintenance of track and overhead conductors	0·0459
" " buildings	0·0036
" " boilers and machinery	0·0120
" " cars	0·1480
" " workshops	0·0148
Total working expenses per car mile	2·6243

Table III.—Blackpool Electric Tramway.

WORKING EXPENSES FOR 1891.

Total number of car miles for one year	98,000
Average car miles per month	8,166·6
Gross receipts for one year	£7,241
	Per car mile. Pence.
Repairing centre channel	0·345
,, roadway	0·452
Rent, at 6½ per cent. of cost of line, to Corporation	1·773
Repairs of armatures, fittings	0·461
Decorating and plumber's work	0·189
Fire and boiler insurance	0·019
Ground rent	0·125
Wages of drivers, conductors, engineer, ticket clerk, &c.	3·260
Coal, oil, waste, &c.	0·714
Water and gas	0·223
Rates and income tax	0·874
Printing and stationery	0·076
Salaries of directors, secretary, auditors, and clerks..	1·187
Compensation for damages	0·016
Miscellaneous	0·197
Total working expenses per car mile	9·911
Ratio of operating expenses	57·8 p.c.

TABLE V.

WORKING EXPENSES OF FIVE REPRESENTATIVE AMERICAN ELECTRIC TRAMWAYS.

	Road 1.	Road 2.	Road 3.	Road 4.	Road 5.
	Per Car Mile.	Per Car Mile.	Per Car Mile.	Per Car Mile.	Per Car Mile.
Permanent Way.	d.	d.	d.	d.	d.
Maintenance of road-bed and track	0·225	0·335	0·475	0·085	0·050
Maintenance of line ...	0·035	0·075	0·100	0·105	0·030
Maintenance of Power Plant.					
Repairs of engines and boilers	0·018	0·055	0·195	0·013	0·036
Repairs of dynamos ...	0·008	0·007		0·013	0·008
Miscellaneous repairs ...		0·118		0·019	0·004
Cost of Power.					
Fuel	0·335	0·483	0·822	0·345	1·073
Wages at generating station	0·296	0·186	0·212	0·196	0·437
Oil and waste	0·032	0·077	0·102	0·029	0·109
Water	0·046	0·035		0·027	0·147
Other supplies	0·005	0·010		...	0·116
Maintenance of Rolling Stock.					
Machine shops, and repairs to motors and cars	0·922	0·414	1·503	1·162	0·293
Transportation Expenses.					
Wages of conductors and motor men	2·318	1·778	2·236	2·516	1·826
Miscellaneous wages for inspectors, trackmen, and cleaners	0·526	0·159	0·095	0·018	1·234
Accidents to persons and property	0·013	0·053	...	...	0·003
General Expenses.					
Insurance...	0·766	0·094	0·230	0·036	0·084
Salaries, &c.		0·324		0·272	0·685
Office expenses	0·021	0·014	0·081	...	0·035
Advertising, printing, legal and miscellaneous expenses	0·035	...	0·094	0·693	0·131
Total expenses per car mile	5·601	4·217	6·145	5·529	6·301

Table VI.—West End Railway Company of Boston.

WORKING EXPENSES FOR FIVE MONTHS ENDING AUGUST, 1891.

	Electric Traction.	Horse Traction.
Gross receipts	£29,337 6s.	£78,779 4s.
Track and car expenses ...	9,030 8s.	26,729 6s.
Motive power	5,733 0s.	23,949 0s.
Total operating expenses ...	16,274 2s.	55,043 4s.
Miles run	375,474·8	1,093,808·2
Ratio of mileage	25·75 p.c.	74·25 p.c.
Ratio of operating expenses	55·47 p.c.	69·87 p.c.
Total expenses per mile run	10·41d.	12·06d.
Gross receipts per mile run	18·76d.	17·26d.

Table IV.—The Florence and Fiesole Electric Railway.

WORKING EXPENDITURE, BASED ON AN AVERAGE OF 600 CAR KILOMETRES, OR 375 CAR MILES, PER DAY.

	Per Car Mile. Pence.
Traffic—	
11 guards and 3 inspectors	0·960
Maintenance—	
Inspector, foreman, and 8 men	0·680
Motive Power—	
Wages at generating station	0·386
10 car drivers	0·898
Fuel, 1 ton per day, at £1 12s. per ton	1·003
Water, oil, repairs, and sundries	0·513
Depreciation and Renewals—	
Boilers, 7 per cent.; electric plant, 8 per cent.; cars, 5 per cent.; line, 1 per cent	2·080
General Charges—	
Rates and taxes, office, and administration ...	1·050
Total per car mile	7·570

THE GOVERNMENT AND THE TELEPHONE.

FOLLOWING a general meeting of the London Chamber of Commerce, held last Monday at their offices, Eastcheap, a deputation of those interested in this subject waited upon the Postmaster-General in the afternoon in his room at the House of Commons.

Sir ALBERT ROLLIT, M.P., who introduced the deputation, said that it was representative of the commercial feeling, not only of London, but of the country at large. They came to the Postmaster-General because the London Chamber of Commerce had taken so great an interest in the subject of telephonic communication, that an association had been formed in connection with it for the purpose of improving the means of communication by telegraph, telephone, and otherwise, their main object being to secure the best and cheapest service. The Chamber knew that despatch was an essential element of profit, and that unless this were attained, it was impossible to compete with other nations in relation to commerce. Consequently the opinion of the Chamber was that every facility should be given to the industry, seeing that it was the product of so much expenditure and scientific knowledge. At the meeting of the Chamber, the members complained in strong terms that the existing facilities were neither so great, nor so cheap, as the state of commerce demanded. On the other hand, the representatives of the telephone companies urged that they lacked powers for the proper performance of the duties entrusted to them. The Chamber felt that some of the powers claimed by the companies were too wide, and, if granted, would lead to a large amount of private and public inconvenience. The Chamber, after considering the various aspects of the question, passed a resolution expressing its views as to the supreme importance of Her Majesty's Government bringing in a General Powers Bill, which would afford facilities for the development of the telephone, not only in the metropolis, but also in regard to inter-town service throughout the country, whether conducted by private companies or by the Government.

Mr. FAITHFULL BEGG also spoke in support of the objects of the movement, as did Mr. SHERIFF FOSTER and Mr. W. C. JACKSON, the last of whom stated that he represented the Telephone Subscribers' Protection Society, with a membership of about a thousand.

Mr. SIDNEY MORSE, representing the electric lighting industry, contended that the telephone companies should be regulated by the Board of Trade, as were those companies for which he appeared.

Sir JAMES FERGUSSON, in reply, said that he supposed the promoters of both the private Bills dealing with the subject now before Parliament were in favour of the general object of the deputation. The companies must, undoubtedly, even in their own interest, desire that telephonic facilities should be increased, and that the restrictions standing in the way of their extension by means of the companies should be removed. Ever since he had come to the General Post Office he had given anxious and particular attention to the subject, and he would be prepared when the private Bills promoted by the two companies, or groups of companies, came up for second reading on Tuesday to make a general statement as to the policy of the Government and the scheme which it had formed for the promotion of the objects now brought before him. In these circumstances it would not be respectful to the House of Commons to anticipate that statement; but he assured them that the matter was one to which the Government had given much attention, and the objects of the deputation would be promoted and supported by the interesting statements placed before him.

In the House of Commons last Tuesday night, on the motion for the second reading of the New Telephone Company Bill,

Sir JAMES FERGUSSON (Postmaster-General) said: I think that the House will, perhaps, allow me to state the course which the Government find it necessary to take with regard to this Bill, and, incidentally, the policy which they intend to pursue with reference to the very important question concerning the telephone system. The Bill now before the House is in itself moderate in character. It really seeks to obtain for the New Telephone Company

statutory powers similar to those provided by the Post Office by the Act of 1863. Except in a single particular, I do not know that the powers asked for would be excessive if it were desired by Parliament that private telephone companies should be placed in possession of separate statutory powers. That has never hitherto been the case. But the telephone interest is in a very different position to that of gas, electric lighting and water companies, and so forth, because none of these touch or trench upon the prerogative of the Crown. But it has been decided by the High Court of Justice that telegraphs and telephones are the monopoly of the Post Office, and accordingly no separate powers have ever been conferred upon the telegraph companies, but they have carried on their proceedings under license from the Postmaster-General. I need not trouble the House with the whole history of the telephone. The House is familiar with it, as it has been the subject of inquiry before a Select Committee. Still, I should like to remind the House that the policy pursued by my predecessors, to whatever party they belonged, was to grant licenses to commercial companies for the erection and maintenance of telephones. These licenses were at first restricted, but were afterwards made universal; in fact, 13 companies were granted powers extending over the whole kingdom. It was intended by my predecessors that there should thus be commercial freedom, and that the country might be efficiently served by the competitive efforts of these companies. The result cannot be said to have been wholly satisfactory. For gradually these companies had been amalgamated or absorbed by one large company, the National Telephone Company, which has made greater advances than any other undertaking in this country. But there are some which are, of course, in a smaller group, headed by the New Telephone Company, by whom the present Bill is promoted. There has been many representations of late by public bodies of the inadequacy of the telephone system. Only yesterday I had a very large deputation of the London Chamber of Commerce, who represented that it was very desirable, in fact, that it was really important, that Her Majesty's Government should bring in a General Powers Bill, so as to afford facilities for the development of the telephone, not only in the metropolis, but all over the country. Well, in view of what I believe to be the very general opinion, and of the consistent policy of the Post Office, it will be my duty, on the part of Her Majesty's Government, to oppose the second reading of this Bill, and *à fortiori* of the Bill promoted by the National Telephone Company, which is not at this moment before the House, but which has been read a first time, and which seeks powers much wider than have ever been asked by the Post Office. The fact is, as I have said, that owing to the failure of the intentions of Her Majesty's Government, the telephone system has made less progress than it has in any other country of Europe. Whereas in France and in Germany it has made very great strides, so that a considerable percentage of the people are users of the telephone, and in England a very small fractional portion only of the people are in enjoyment of the telephone, and in London, the largest city of the world, one-fourth of the number of persons are users of the telephone that there are using it in the City of Berlin. The form of license issued by the Post Office has something to do with the hindrance to the development of the system. The licenses confine the companies in their operations. They, for instance, restrict the companies from writing down or delivering messages, which is the process in France where the telephones belong to the Government. And they cannot communicate with the Post Office unless under considerable charges. They cannot make their lines along railways, canals, and roads where the Post Office have the entire concession, without paying a heavy wayleave. Now, sir, not to weary the House, but to proceed towards the point at which I desire to arrive, I wish to say that ever since I have occupied my present office, I have given my earnest attention to the subject of how to devise a system that in the first place, instead of restraining, will facilitate the development of the telephone interest, while, in the second place, sufficiently guarding the Post Office monopoly, which, though an ugly word, really expresses the interest of the public in the telegraphs they have acquired. I do not think, sir, that these two objects are at all incompatible, and it was our desire to frame a scheme which will develop the telephone system, while it enables the Post Office to work in alliance with it. But that there is real danger of the telegraph property of the public being injured, if due provision be not made for its protection, I think, is shown by the fact that wherever the telephone system has been particularly developed, there the growth of the telegraph revenue has been checked. The telephone system has been more considerably developed between large towns of Lancashire and Yorkshire than perhaps anywhere else, but in whatever part of the country it has been developed, there the telegraph revenue has been checked. But the concessions which might be made to the telephone companies mainly consist of these:—Messages may be communicated from the telephone, and communicated to the public telegraph wires, so that there may be free communication between the two, and messages may be sent by any telephone subscriber to be delivered to his correspondent. At present that cannot be done. Messages might be sent as letters by post, and receive the service of the express messengers. No charge shall be made in the Post Office for the work of taking down the telephone messages and despatching them by telegraph or by post; and the wayleave now charged over railways shall be reduced from 20s. per mile per year to a nominal sum. Lastly, that the companies should be allowed to establish call offices in post offices. There are other possible concessions, but these are on matters of detail. Also, sir, the Government are prepared to facilitate legislation, giving certain moderate powers for the construction of telegraphs by their licensees. I would point out that these concessions, if granted without corresponding provisions of protection of the public revenue, would be very dangerous. For if the telephone companies were in communication with all the large towns, and they sent messages all over the country, undoubtedly the system would, to a large extent, supersede the use of the telegraph, and consequently largely diminish the telegraph revenue. Therefore it is an essential feature of the scheme that the Government should have possession of the trunk wires. Experts in the House will of course understand the distinction of terms. Perhaps it will be well to state that the telephone exchange consists of a comparatively small number of private wires, that is to say, wires leading to private houses or offices. Exchanges are really small groups, which must be connected, even in a town, with other exchanges, and then by the trunk wires, they come into communication with one another. It is our view that we ought not to interfere with the commercial business of the companies in establishing exchanges wherever their enterprise may lead them, but that the junction of these exchanges should be in the hands of the Government. The trunk wires should be in the hands of the Government in order that the public may have their portion of the sum paid for messages in the same way as with telegrams. That could be fixed at a moderate rate in order not to check the development of the telephones. With regard to the main lines or wires connected with exchanges in towns, it is desirable from another point of view that they should be in the hands of the Post Office. If the telephone companies become largely developed, there would be an infinite number of cable wires connecting the various exchanges, and, as in the City of New York, they might in time become a serious inconvenience and danger to the public. Moreover, any local body, as in New York, might be put to the immense expense of removing them from overhead and placing them underground. If these rival companies, operating in the same town or area, possessed powers to take up the public streets and lay down underground wires, not only infinite confusion and disturbance might be caused, but the traffic and private rights might be interfered with. But if the Post Office has the power to make these main connections, they could lay wires side by side to accommodate all the different exchanges—the exchanges running separate wires for their own service, and so the work would be done with the least possible disturbance, and should increase the accommodation to the public. But here I should like to say that any such powers would naturally be viewed with great jealousy were they not exercised in complete harmony with the local authorities; and it is the intention of Her Majesty's Government, both in the additional powers they propose to confer on the companies, and in the additional powers which they propose to seek from this House, to carry the local authorities with them throughout. One large branch of the question is how far the extension of licenses is to be pursued. It is contrary to sound policy to give licenses to men of straw, who get licenses only for the sake of selling them, or, in a sense, for levying blackmail upon the existing companies and solid organisations. Therefore it is the view of Her Majesty's Government that fresh licenses should not be given all over the country. That almost follows on the desire of the Government to possess the trunk wires. Before a fresh license is given to organised parties operating in certain areas, the condition must be imposed that they are possessed of the capital and the means to carry out their undertaking. Wherever the local authority are satisfied that a telephone exchange is desirable, and the Government are satisfied that the licensees are in a position to carry out their undertaking, and that it is in the public interests desirable that they should have a license, then we will grant a licence for such area. Now, sir, it is my intention on the part of the Government to move, in a few days, for leave to bring in a Bill to confer additional powers upon the Post Office in respect of the telegraphs and telephones. It is unnecessary, perhaps improper, just now to indicate what those powers will be. They will be very moderate, and will infringe on no private rights. We will carry the local authority with us everywhere. We will give a slight extension of existing powers where those existing powers are insufficient for the development either of this new modern enterprise, or of small extensions of telegraphs, where the public necessity requires. It is extraordinary how local authorities and private individuals can interrupt the making of the most moderate extension for months. There was a case the other day of a gentleman in Kent who, as the condition of allowing a post to be placed upon his premises, insisted that on his Yorkshire estate there should be a post office maintained for all time. Very often there are petty and private objections which, in the public interest, should be overruled by proper authority. I do not think, sir, I will go further into the matter just now. I do not think the House will be prepared to establish private companies in a position of strong opposition to the Government telegraphs, such as would be created by this Bill. One condition of the Bill would enable the New Telephone Company to make agreements with electric light companies for placing their wires in the lighting companies mains. The effect of that might be to give the company possession of those mains, to the exclusion of all other companies, absolutely precluding the fair competition, and defeating the intention of the Post Office to give all their licensees a fair chance. I must, as a matter of form, move that the Bill be read a second time this day six months; but I have every reason to believe that the promoters of the Bill, with whom I have been in communication, as well as all other persons concerned in this industry, will not press it, in view of the statement I have made.

After a slight discussion, the second reading of the New Telephone Company Bill was formally postponed until Tuesday.

The following were the notices on the paper in regard to this Bill, and of course they stand over for the adjournment:—

Mr. KIMBER: On second reading of New Telephone Company Bill, to move, That it be read a second time upon this day six months.

Sir ALBERT ROLLIT: On second reading of New Telephone Company Bill, to move, That it be read a second time upon this day six months.

Sir J. WHITTAKER ELLIS: On second reading of New Telephone Company Bill, to move, That it be read a second time upon this day six months.

Mr. R. G. WEBSTER: After second reading of New Telephone Company Bill, to move, That the Bill be committed to a select committee of nine members, five to be nominated by the House and four by the committee of selection.

That all petitions against the Bill presented three clear days before the meeting of the committee be referred to the committee; that the petitioners praying to be heard by themselves, their counsel, or agents, be heard against the Bill, and counsel heard in support of the Bill.

That the committee have power to send for persons, papers, and records.

That five be the quorum.

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Mr. DIXON-HARTLAND: After second reading of New Telephone Company Bill, to move, That the Bill be committed to a select committee of nine members, five to be nominated by the House and four by the committee of selection.

That all petitions against the Bill presented three clear days before the meeting of the committee be referred to the committee; that the petitioners praying to be heard by themselves, their counsel, or agents, be heard against the Bill, and counsel heard in support of the Bill.

That the committee have power to send for persons, papers, and records.

That five be the quorum.

Mr. MATHER had on the paper a notice that he would ask the Postmaster-General whether, in view of the great commercial importance of the question of telephonic communication generally, he would inform the House when licenses would be granted by him to companies which have established telephonic exchanges in many localities throughout the country, and which were now inactive in consequence of the delay arising out of the withholding of such licenses by him: And, whether he was aware that in the township of Denton, near Manchester, a district isolated from that city, all necessary apparatus for a telephonic exchange had been for some time erected, and that the subscribers were anxiously waiting for the opening of the local exchange, which the Solicitor to the Post Office had prohibited until the licence had been granted. In putting this question, Mr. Mather said the statement of the right hon. gentleman had answered the first part of it, but he would like to ask whether provisional licenses would be granted in districts where exchanges had been established and apparatus erected granted, that was to say, until the passing of the Bill.

Sir JAMES FERGUSSON: Certainly; but the hon. gentleman must remember that each case must be considered on its merits. The case of Denton is now under consideration.

PARLIAMENTARY NOTES.

ELECTRIC AND CABLE RAILWAYS.

In the House of Commons, last Monday,

Mr. WHITMORE moved: "That the resolution of the House of March 1st, relative to Electric and Cable Railways (Metropolis), which was ordered to be communicated to the Lords, and the message from the Lords of March 7th, signifying their concurrence in the said resolution, be read; that the said Select Committee of the Lords do consist of five members, to be nominated by the Committee of Selection; that a message be sent to the Lords requesting their lordships to appoint an equal number of Lords to be joined with the Members of this House." The motion was agreed to.

Regarding the same matter, it was agreed on Tuesday, on the motion of Mr. KIMBER: "That it be an instruction to the Joint Committee of Lords and Commons relative to Electric and Cable Railways (Metropolis) that, as regards any schemes for which Bills have been deposited, the said Committee have power to hear the parties promoting any such Bill before reporting whether it should be not proceeded with."

COAST COMMUNICATION (PAST AND PRESENT).

A PAPER on this most necessary and urgent want of the day was read last Friday evening by Mr. H. Benest, C.E., at the weekly meeting of the Balloon Society at St. James's Hall, Piccadilly. In the unavoidable absence of Rear-Admiral Mayne, C.B., M.P., the chair was taken by Mr. R. Kaye Gray.

Mr. BENEST said that all the islands, rock lighthouses, and lightships should be in connection with the mainland at points, as near as practicable, to coastguard and lifeboat stations, these stations in turn being in continuous telephonic communication with one another and adjacent postal telegraph offices.

Speaking of what had been done in the past towards establishing signal stations on our coasts, he gave brief accounts of the experiments with the *Brisk* at the entrance of the English Channel in 1870, and the trial of the telegraph cable to the Sunk Lightship off Harwich, commenced in 1884 and abandoned a few years ago. He showed that one attempt had been made in the direction of connecting-up lighthouses. That of the Fastnet in 1884, which, after several interruptions and expensive repairs to the cable, was abandoned in the third year of the installation. He considered the conditions favourable there to the safe existence of a cable, once properly protected from the force of the sea. He pointed out that something beyond an experimental state had been reached. Although much had been *said*, but little had been *done* towards arriving at a comprehensive system of communication with outlying stations.

In referring to Lundy Island, and the recent experiences of H.M.S. *Banterer* in that locality, he said it would be necessary to lay the cable clear of the tide race, which was the cause of its frequent failure.

Coming to the present, he dealt with the connecting-up for Lloyd's of Tory Island on the N.W. coast of Ireland with the mainland at Pollaquill Bay in July, 1890, and showed that it had been an unqualified success, having worked without interruption since its opening a year and eight months ago. He drew attention to Tory Island being the only outlying station on the coast of the United Kingdom in communication with the mainland, and contrasted this communication unfavourably with the 157 miles of telephonic lines in existence on the coast of Jutland, in the kingdom of Denmark, connecting together fifty lifeboat and rocket stations.

He considered that the War Office should take an interest in coast communication, as in time of war it would be invaluable, and that all wires should be subterranean.

Coming to the consideration of what could be done, and how to do it, he suggested that a committee be formed of outside experts, engineers, and mariners. He said that preliminary trials might be made of connecting up certain groups of lightships, also certain lighthouses with the coast. In continuing, he touched upon various methods which might be brought into use for protecting the cables from the action of the sea in connection with lighthouses, and a plan he thought might prove feasible for establishing communications with lightships.

After a short discussion, it was proposed by Mr. E. J. Hobbes, seconded by Mr. C. J. Leslie, and adopted unanimously—"That, with a view to the better prevention of loss of life and property in cases of vessels in distress or shipwrecked, and to give the earliest possible information to lifeboat authorities and rocket apparatus stations, it is desirable that a complete system of telephonic and telegraphic communication should be provided by Government round the coast of the United Kingdom; that the coastguard and signal stations be also connected; and that on those parts of the coast where such stations do not exist, the postal telegraph offices nearest to the lifeboat stations be telephonically and telegraphically connected therewith."

NOTES.

Paris-Brussels Telephone.—The *Financial News* states that the works on the third circuit of the Paris-Brussels telephone are nearing completion.

Elmore Copper in France.—The first Elmore copper works in France, were, according to the company's statement, to be opened last June. It appears, however, that they were only set in operation a fortnight ago at Dives (Calvados).

Railway Telegraphs in France.—The working of the railway telegraphs which has been hitherto carried out by the employés of the State, will from April 15th come under the direct control of the large railway companies, who will employ the necessary operators.

Electric Lighting at Cambridge.—At a meeting of the Cambridge Town Council held last week, the Electric Lighting Committee reported that Messrs. Parsons & Co. had offered to commence the electric light within the area of supply, not later than the beginning of October term next, and to proceed with all possible despatch. The system employed would be the alternating current system. The charge per unit should not in any case exceed 7d., and the company should pay £1,000 towards the expenses of the Corporation, who should have the power to acquire the undertaking at the end of 21 years, upon paying for the undertaking as a going concern. The committee considered the terms to be fair and reasonable, and recommended the Council to adopt them, and to instruct the Town Clerk to prepare an agreement in accordance with the provisions contained in the Provisional Order relative to the transfer of the powers of the Corporation under the Order.—This report was unanimously agreed to.

Our American Contemporaries.—According to the New York *World*, Walter T. Hunk was, on February 22nd, enjoined in the Supreme Court from working for the *Electric Age* Company, and that corporation was restrained from employing him. Suit was brought by the W. J. Johnston Company, publishers of the *Electrical World*. It was claimed that Hunk agreed in June, 1890, to work for Johnston exclusively, at $4,000 annually for five years. In June, 1891, Hunk demanded $10,000 in cash, threatening that unless it was forthcoming he would go to the *Electric Age*, and take "half the business with him." His demand was refused, and he became identified with the *Age*. According to the decree of the court, Hunk cannot resume his connection with them until June 1st, 1895.

Economic Aspect of Sewage Purification by Electricity.—Referring to our remarks upon this subject in a recent issue, a correspondent writes referring to the paragraph in which we state:—"Mr. Grimshaw has compiled for the Society of Chemical Industry some exceedingly significant statistics." He says that this would give one the opinion that the society had requested Mr. Grimshaw to compile these statistics. We are informed, however, that Mr. Grimshaw merely read the paper on sewage before the Manchester Section of the Society, copying the figures from the Society's Salford report.

The Double-Carbon Lamp Case in America.—According to the *Electric Age*, the Brush Electric Light Company on March 1st scored an important victory in the United States Circuit Court. In its suit against the United States Electric Lighting Company, asking for an injunction restraining the latter company from using the double-carbon lamp, which was patented by Charles Brush, September 2nd, 1879, the Court granted a perpetual injunction. The defendant company is also required to appear before United States Commissioner Shields to render an account of profits made on the use of the disputed patent in the past two years.

Nickel Heat Engines.—Some correspondence has recently been appearing in the columns of *Nature* regarding a new form of heat engine described some weeks ago by Mr. F. J. Smith. Mr. Karamate states that Mr. Smith's device is similar to one by Prof. Stefan, but Mr. Smith points out that the two heat engines are quite different in design. In giving a comparison of the two machines, he says that the distribution of the magnetic field, due to two poles, is entirely different in his engine from that in the machine of Prof. Stefan. Mr. Karamate asserts that by heating a nickel plate before the magnet, it was repulsed by the magnet; but Mr. Smith fails to see how such repulsion takes place, and he quotes Faraday's remarks, on the behaviour of nickel, as a vindication of his own statements. Surely, says Mr. Smith, the action of the engine is due to one piece of nickel becoming partly non-magnetic, owing to a rise of temperature, thus upsetting equilibrium, and allowing the next piece of nickel to approach the magnet, and consequently the flame.

Not Wanted Here.—The following sample of waltzes and quadrilles danced at the second annual ball of the Brotherhood of Electrical Mechanics in Chicago at the beginning of this month is probably unique:—"Edison," "Magnetic," "Electricity is Life," "Simplex," "Closed Circuit," "Siemens," "Okonite," "Compound Wound," "Shocking," "Habishaw," "Low Tension," "100,000 Volts," "Induction," "Multiple Arc," "Incandescent," "The B. of E.M.," "High Tension," "Grimshaw," "You Press the Button, We do the Rest," "Safety," "Alternating," "Dead Ground," "Short Circuit," and "Lights Out." The refreshments were of course of a similar order: Battery fluid, low tension wine, electric current juice, electropoion fluid, dynamo oil, asphaltum, Jersey lightning, alternating campaign, P. and B. paint, short circuit soda, and high tension whiskey. No wonder some of the members of the Brotherhood declined to take tickets.

The Electric Light in Japan.—The Yokohama Union Electric Light Company does not appear to be at present in very smooth water. At the annual meeting recently held it was agreed, that as the profits were too small to allow of a reasonable dividend, they should be used for creating an extension fund. The recent earthquake in Japan had cost the company about £1,000.

Royal Institution of Great Britain.—On Friday evening next a discourse will be given before the members of this Institution by Prof. Oliver Lodge, F.R.S., &c., on "The Motion of the Ether near the Earth."

"Transforming" a Church.—A church known as the Epworth Church at Baltimore, Ind., U.S.A., is at present being converted into a power generating station for the Baltimore Traction Company.

The Electric Light in Switzerland.—The town of Lauffen is to be lighted by electricity. The work is in the hands of Messrs. Schuckert & Co., of Nuremberg.

Isle of Man International Exhibition, 1892.—Mr. George North, M.I.M.E., of 90, Queen Street, London, E.C., has been appointed representative for London and the South of England for the above exhibition, which will be opened on July 4th next. Intending exhibitors can obtain all information on application to Mr. North.

Derby Electric Lighting.—A deputation from the Corporation of Derby, who are consulting Messrs. Bramwell and Harris, electrical engineers, in reference to the lighting of that town, visited Bath last week for the purpose of inspecting the electric lighting works.

Electric Lighting of Rockhampton.—A report of the directors of the Rockhampton Gas and Coke Company, Limited, published a few weeks ago, says, that "Since the last general meeting of shareholders, the directors have taken a definite step in the matter of the electric light. After careful consideration it was decided to instruct the company's London agents to invite applications for the position of electrical engineer to the company, and out of a large number of applicants, Mr. A. E. Neal, formerly of Birmingham, was selected. He has reported on the systems of electric lighting most suitable for Rockhampton. As the early introduction of the electric light will be advantageous to the company in a variety of ways, the directors have decided to proceed with it without delay, and have accordingly purchased a quarter of an acre of land in Alma Street, between William and Denham Streets, for the erection of the works. The directors have undertaken to supervise, through the electrical engineer, the electric light operations at the Mount Morgan Gold Mining Company's works."

Dynamo Nomenclature.—An interesting paper was read at a recent meeting of the Physical Society, by Professor S. P. Thompson on "Dynamo Nomenclature." Our contemporary *Industries*, states that Prof. Thompson first dealt with the old Ampère mnemonic rule. Regarding this rule, our contemporary questions whether anybody has ever been able to remember it; there is always much trouble in finding out whether the current goes in at the head or the feet or the arms. Maxwell's right-handed cork-screw is perhaps the simplest of all methods. It is unfortunate that areas are reckoned counter-clockwise. Mr. Perren Maycock's rule is very simple. By it, if a wire be grasped by the right hand, the fingers represent the lines of induction and the thumb the current in the conductor. Dr. Fleming's rule, taken with reference to electromotive force instead of current, is very handy. The next point mentioned was the diagrammatic mark to show the direction of a current. Dr. Thompson uses an arrow, and it was suggested that a bow could therefore be used to show the direction of the electromotive force. The bow would be like a D with the straight part left out. The round part is put in the direction the electricity is urged. The point then shows the direction. Dr. Thompson also exhibited an ingenious model for explaining such things as triple currents. He also showed how to represent alternating currents that do not vary harmonically by means of a sort of Zeuner diagram. It is questionable, however, says *Industries* if these last diagrams are of much practical use.

Nuneaton Lighting.—At a recent meeting of the Nuneaton Local Board, reference was made to the lighting of the town. Taking into consideration the high price of gas, it was said to be an open question whether the electric light could not be supplied more economically. The matter is to be discussed in a month's time.

Personal.—Mr. Arthur C. F. Webb, M.I.E.E., who is on the Technical Staff of the Government Telegraph Department of New South Wales, and chief instructor to the technical school attached to that department, has recently been also appointed by the Minister for Public Instruction to give a course of lectures on Electrical Engineering at the Sydney Technical College. The course commenced about six weeks ago, and promises to be very successful, upwards of sixty students having already entered for it. The opening lecture is described by one of our New South Wales contemporaries as being of a most instructive and practical nature. Mr. Webb, who is a son of Mr. F. H. Webb, secretary to the Institution of Electrical Engineers, was for some years with Prof. George Forbes, F.R.S.

Photographing Bullets.—In a lecture on this subject, delivered recently at the South Kensington Museum, Prof. C. V. Boys explained his apparatus for the purpose. It consists of a box lined with black cloth, in which the photographic plate is exposed; of a condenser formed of a plate of glass about a foot square; of a smaller condenser in the form of a bottle, to act as a starter of the spark; and of a system of wire circuits and knobs to give the spark which throws the shadow of the bullet on the plate, and thus takes the photograph. The bullet enters and leaves the box by two holes, covered with paper to exclude the light; and in passing the plate the bullet touches the terminals of two wires, composed of thin lead wire, thus partly completing the circuit; a small flash passes from the smaller condenser, causing a larger flash to pass between the knobs of the plate condenser inside the box; and this flash, lasting less than one-millionth of a second, takes the photograph of the bullet, no lens being employed. A wet string in the circuit of the small condenser is used to damp the electrical oscillations. Mr. Boys was able to infer from his experiments with a rifle that the bullet must have received some 3 per cent. of its velocity after leaving the muzzle, at which point the turning effort of the rifling must have necessarily ceased.

Public Lighting at Carmarthen.—At the last ordinary meeting of the Carmarthen Town Council, the question of the public lighting of the town was brought forward. The Clerk reported that the local gas company, fearful of the threat made some time ago that electricity would be introduced as a public illuminant, had consented to reduce the price of gas from 5s. to 4s. 10d. for private consumers, and 4s. 6d. for the Corporation. After some discussion it was decided to accept the offer of the gas company, and allow the electric lighting matter to remain in abeyance for the present.

Liverpool Electric Lighting.—It will be remembered that a short time since fires occurred in several of the boxes containing the electric wires underneath the paving of certain streets. Major Cardew, says the *Liverpool Courier*, was recently sent down by the Board of Trade to make an examination. A copy of his report on the subject to the board was submitted to the Watch Committee last Monday. This provoked a great deal of discussion. Ultimately the city engineer was instructed to make an inspection of the street boxes, and present a report to the committee.

The Search Light for Night Warfare.—On Saturday last the night attack on Elstree by the London Rifle Brigade was rendered especially interesting and novel on account of the use of a powerful search light on the defending side, which it will be seen from the reports in the daily papers was the means of frustrating the tactics of the enemy just as they had victory within their grasp. The whole of the gear was supplied and put into position by Ronald A. Scott, M.I.E.E., who is so well known as a large manufacturer of search light apparatus. The ground where the plant had to be fixed was ankle-deep in mud; but, nevertheless, the installation was thoroughly satisfactory, the light running for nearly three hours without a hitch. Mr. Scott was ably assisted by Messrs. Garratt, Toy, Meade, and H. Onslow, B.A.

A New Primary Battery.—Mr. Mond (of the firm of Brunner, Mond) has found that by passing mixed hydrogen and carbonic oxide over nickel and cobalt he can separate them, and then, by applying the hydrogen, as in Grove's experiment, to strips of platinum, he gets a powerful battery. This battery will yield, it is stated, 50 per cent. of the total energy in the hydrogen absorbed; whereas if the same gas were burned under a boiler to make steam, and the steam used in a first-rate engine, which was again employed to drive a dynamo, the yield of electricity would, under the most favourable conditions, not exceed 8 per cent. of the energy in the gas.

The Electro-Harmonic Society.—The final Smoking Concert of the season will take place on Friday evening next, when a specially good programme will be placed before the members. The vocal element will be of a high order, and two instrumental novelties will be introduced in the shape of quartets for four violins. The full programme can be seen in our supplement.

Pontypool Lighting.—In consequence of the strenuous opposition of nine different public and private bodies, including a local electric light company, the Pontypool Gas Bill has been withdrawn, as the promoters saw it would be a hopeless task to rule down such opposition.

Festiniog and Electric Lighting.—Festiniog has decided to discard gas and use electric light to illuminate the streets. It was resolved recently that the Local Board should take the necessary steps to procure a provisional order, and that tenders for the work be invited in due course.

Manila and Electric Lighting.—The *Financial News* states that the Manila municipal authorities offer a concession for 20 years and a subsidy of $60,000 a year in reference to the electric lighting of the town. The contractor is also to be at liberty to supply private houses.

City and South London Railway.—In the Queen's Bench Division on Thursday, March 24th, the case of Saqui and Samuel *v.* South London Electric Railway Company, came before Mr. Baron Pollock and Mr. Justice A. L. Smith, sitting as a Divisional Court. Mr. Crump, Q.C., said he had to apply in this case for a writ of *certiorari* to bring up the inquisition by the jury in the compensation case of Saqui and Samuel against the Electric Railway. The ground on which the application was made was that the jury exceeded their jurisdiction in the verdict they gave. Messrs. Saqui and Samuels were sub-lessees of 45, King William Street, which was between 44 and 46. No. 46, the corner building, now was the station of the railway, and the company had sunk a shaft 70 feet deep, and made a tunnel for the conveyance of passengers. The consequence of this undermining of the plaintiff's premises was to cause a subsidence sufficient to make the houses, Nos. 44 and 45, part at the top and to heel over. The jury had awarded the plaintiffs no damages at all. After some discussion their lordships granted a *rule nisi* for a *certiorari* to bring up the verdict.

Electric Lighting for the Duke of Montrose.—His Grace the Duke of Montrose has decided to light Buchanan Castle by means of the electric light, and has called in Messrs. Drake and Gorham to carry out the work. They are arranging to make use of the water power. The water will be taken in pipes from a point about 1,400 yards from the Castle, the turbine and dynamo being placed midway between this point and the accumulators, which will be placed in the Castle itself.

The "Eastern" Potentate.—The *St. James's Gazette* states that Sir John Pender was received in private audience of the Sultan at Constantinople on Saturday, and had a conversation with His Majesty on the progress of telegraphy and other matters. The Sultan conferred upon Sir John Pender the gold and silver medals of the Order of Imtiaz as a special mark of his esteem and regard. Sir J. Pender subsequently embarked on board the *Mirror* on his return home, *viâ* Athens and Italy.

BUSINESS NOTICES, &c.

The Electric Lighting Installation at Bolton Technical School.—The electric light installation for the lighting of the Bolton Technical School, which was formally started on Saturday, March 19th, by Alderman Dobson, has been supplied and erected by Messrs. Ernest Scott and Mountain, Limited. There are two dynamos of the Tyne compound-wound type, fitted with heavy turned fly-wheels and fast and loose pulleys for generating the current, each machine giving an output of 90 ampères at an E.M.F. of 100 volts, when running at a speed of 900 revolutions per minute. The sliding bed-plates of both dynamos are provided with tightening screws and holding down bolts, enabling the slack of the belt to be taken up. The power for driving the dynamos is obtained from two 14-H.P. nominal Griffen gas engines, which have been supplied by Messrs. Dick Kerr & Co., of Kilmarnock. Countershafting is arranged so that either engine can drive either dynamo, the power being transmitted by belting. The current from the dynamo is conducted by cables to a main switchboard, which is of a very substantial design, and consists of an enamelled slate base, fitted with four of Messrs. Ernest Scott and Mountain's double pole switches with fusible cut-outs, the switches being arranged to control the lights in the basement, ground floor, first floor, and second floor. Two coupling switches are also fitted on the slate base, arranged so that the dynamos can be coupled in parallel, or can be run independently or singly as required. The total installation consists of about 220 16-C.P. incandescent lamps, suspended by flexible pendants from the ceilings in the workshops. In the lecture theatre arrangements have also been provided, so that the current can be utilised for working the magic lanterns or microscopes, or for demonstrating the uses of electricity, either as motive power, or for chemical purposes. The installation has been split up, and a large number of switches fitted so that the current can be economised as much as possible, and generally the installation throughout is of a very perfect and complete description. We may mention that Messrs. Ernest Scott and Mountain, Limited, have recently completed a large installation for the lighting of the printing works of the Bolton *Evening News*, and have also lighted up the Rothwell Hosiery Company's mills at Bolton.

The Electric Light in the West End.—The great development in the adoption of the electric light in London is not confined to the city, nor yet to the St. Pancras district. A recent visit to the West End shows that a large amount of work is at present being carried out there. We noticed that Messrs. Rashleigh Phipps and Dawson, of Berners Street, are fitting up an installation in the premises of Messrs. Buchanan, 215, Piccadilly.—The Planet Electrical Engineering Company, of Westminster, are fitting up an installation in the new premises of Messrs. Spink and Sons, gold and silversmiths, in Piccadilly.—The Albemarle Hotel, in Piccadilly, is at present in course of enlargement, and Messrs. Edmundson's, Limited, of 19, Great George Street, Westminster, have the contract for the electric lighting work.—Messrs. Bourne and Grant, of 15, George Street, E.C., are carrying out an installation at No. 90, Piccadilly, while Messrs. H. and J. Cooper, Great Pulteney Street, W., have a similar contract at No. 144, Piccadilly. The Planet Electrical Engineering Company are engaged in fitting up an installation at No. 13, Hyde Park Corner. Quite a number of establishments are now fitted with the electric light in the Brompton district. Messrs. Gooch's well-known outfitting stores in the Brompton Road are being enlarged, and when completed will be fitted with the electric light by Messrs. Barnes and Low, of 8, Exhibition Road, W.

Tenders Wanted.—Bristol.—Tenders are being invited for the following works for the central electric lighting station, Temple Back, Bristol, for the Bristol Urban Sanitary Authority, viz., (1) for the supply, delivery, and erection of steam alternators and steam dynamos, with Willans engines; (2) for the supply, delivery, and erection of Lancashire boilers and accessories. Tenders must be made on the prescribed forms, and delivered at the offices of the Authority, 51, Prince Street, Bristol, by April 8th, endorsed respectively "Tenders for Steam Alternators and Steam Dynamos," and "Tender for Boilers." Dynamo and boiler makers only will be permitted to tender. Plans and sections of the central station may be seen at the offices of the architect, Mr. Henry Williams, 21, Clare Street, Bristol, and copies of the specifications and forms of tender may be seen and obtained at the offices of the Sanitary Authority on and after 25th inst., on payment of £3 for each specification, which will be returned on receipt of a *bonâ fide* tender from parties entitled to tender. Both or either of the contracts may be tendered for. Mr. D. Travers Burges, Town Clerk.

Tenders Wanted.—Basingstoke.—Tenders are invited for lighting the borough by electricity (gas or otherwise) for five years, for the Basingstoke Urban Sanitary Authority. All further particulars may be obtained at the Borough Surveyor's office, Town Hall. Tenders to be sent to Mr. W. H. Bayley, town clerk, Basingstoke, by April 30th.

Launceston Exhibition, Tasmania.—We understand that the following awards have been made to Messrs. Davey, Paxman and Co. for their engines and boilers at the above exhibition. Special 1st award, for 8 H.P. single cylinder portable steam engine, fitted with Paxman's patent automatic expansion gear. Special 1st award, for 16 H.P. Undertype compound engine, fitted with Paxman's patent automatic expansion gear, and special 1st awards for their "Essex" patent vertical boiler, and for their double cylinder winding and hauling engine.

Hotel Lighting.—The contract for lighting the Dublin Hotel Metropole has, it is stated, been placed with the Electrical Engineering Company of Ireland, Limited, under the supervision of Mr. Walter Leake, consulting electrical engineer, of Manchester.

Catalogues, &c.—We have received from the Crompton-Howell Electrical Storage Company, Limited, a copy of their new list of accumulators. In this list the Crompton-Howell accumulators are very fully described; very good illustrations appear, and full information regarding prices is also given. A number of copies of testimonials from users of the battery are printed, amongst others being those from Sir Richard Webster, Q.C., M.P., and Prof. A. B. W. Kennedy. The automatic accumulator switch and cell-testing voltmeter are also minutely particularised. At the end of the pamphlet detailed instructions for the first charge of Crompton-Howell accumulators are given.

The "Gravita" Water-meter.—Mr. M. C. Greenhill, of Mansion House Chambers, has invented a simple and inexpensive water-meter, well worth the attention of all interested in the question of waste prevention. It can be adapted to existing fittings, is suitable to any pressure and to "constant supply," and can be used either in substitution for, or in combination with, existing cisterns. An additional dial, electrically connected with the one on the meter, may be placed at any spot convenient for frequent inspection.

The Electric Light in the Strand.—The new premises of Messrs. A. D. Loewenstark & Sons, jewellers and diamond merchants, in the Strand, are being fitted with the electric light. The work is being carried out by Mr. Julius Sax, of Ridgmount Street, Gower Street, W.C.

Business Alterations.—We hear that Messrs. C. E. G. Gilbert & Co., of 16, Hanway Street, W., have purchased the business of Messrs. Adams & Co., at 35, Kensington High Street, which they will carry on as their West End branch, the head office and works remaining at Hanway Street as formerly.

The Electric Light in Spain.—Tenders are being invited, until the 31st inst., for a concession to erect and operate an electrical central station in the town of Lungo, in Spain. The concession will have a duration of 25 years.

CITY NOTES.

The Direct Spanish Telegraph Company, Limited.

THE half-yearly meeting, being the thirty-seventh ordinary general meeting, of this company was held on Tuesday last at Winchester House, Old Broad Street, E.C., Sir James Anderson presiding.

The manager (Mr. GERHARDI) having read the notice convening the meeting, the minutes of the previous meeting were read and signed.

The CHAIRMAN said that he presumed they would take the report as read. He then proceeded to make a few supplementary remarks on the different paragraphs in the report. The second paragraph referred to a decrease in the receipts of £2,214. At previous half-yearly meetings, he had said that some such result was inevitable if the tariff was further diminished. He had many times in writing and speaking, reminded the public that it took fourteen years for the Post Office to get back the same gross revenue which they enjoyed prior to the introduction of penny postage, and more than twenty years before they got the same net revenue. They were all familiar with the results of great reductions upon their extended submarine cables both to the east and to the west; such reductions had been bold and startling, and such as would, if anything could, have given impulse to the telegraphic traffic, that one would have thought the sacrifice would have been recouped with phenomenal rapidity, but such had never been the case. Only, however, if they reduced the tariff, they broadened the basis from which telegraphy might grow, and they might in most cases gradually recoup their loss in a few years always provided that the reduction had been such as to give a substantial impulse. But what could be said for their poor reduction of ½d. per word, taken from the company's proportion of 2½d. per word, upon the Spanish traffic of 4d. per word? It had simply resulted in the loss of £1,760. A halfpenny per word could have no effect in retarding or increasing external telegraphic traffic. The falling off, as the report showed, was chiefly due to this reduction of rates which the company had to submit to at the International Telegraph Conference. They had to hope, now, that the result was again shown, that the Conference would not continue to reduce tariffs and so make it impossible to maintain submarine cables by private enterprise. Their working expenses were £17 in excess of the corresponding period of last year, but as they had carried 7,800 more telegrams and about 43,000 more words in about the same time, it was not necessary to say anything upon that point. Salaries showed an increase, but every other item showed a decrease. Referring to the cost of repairs item, he said that he had seldom known a more fortunate repair than that of the Falmouth-Bilbao cable. In the month of November, one of the worst winter months, it showed a bad fault 1,900 fathoms in the Bay of Biscay, but fortunately the Eastern Telegraph Company had a ship at Lisbon, and did not lose an hour in trying to effect the repair. The problem now for the directors was how to get back the £2,376 which had been taken from the reserve fund to help pay the cost of these repairs. They said in the report that they hoped to replace it out of future profits, but it might appear to some of them a spendthrift way of looking at the matter. At the same time the directors did not guarantee paying any dividend if the traffic did not warrant it. There seemed to be an elasticity in Spanish trade. They had had some exceptional expenditure, amounting to about £760, which was incurred on account of the removal of their station at Marseilles to the new post-office in that town, and there was also a heavy expense of new underground wires. They had a growing traffic, and must only work and watch. If the Telegraph Conference would only leave their halfpenny alone, they would get on a deal better. He hoped that at the next Telegraph Conference they would be able to influence them. 4d. a word was nothing in an international telegram, and the

worst of that was that they only got 2d. out of that 4d., now that the ½d. came off their 2½d., and that wretched halfpenny had lost them all that money. They could only look forward to doing the best they could by entreating and agitating, but they could do no more. He then formally moved that the report and accounts be received and adopted.

Mr. ETLINGER seconded this, and it was carried unanimously.

The CHAIRMAN next moved that a dividend at the rate of 10 per cent. per annum, less income tax, on the preference shares, and a dividend at the rate of 4 per cent. per annum on the ordinary shares to December 31st, 1891, be paid.

Mr. ETLINGER seconded the motion, which was carried.

Mr. ETLINGER next proposed that Sir James Anderson and Mr. John Denison Pender be re-elected directors of the company.

This was seconded and carried.

The auditor, Mr. H. R. Duke, was re-elected at a remuneration of 20 guineas.

A vote of thanks to the board for their work in the shareholders' interests was acknowledged by Sir James Anderson, and the proceedings terminated.

The Electric Construction Corporation.

AN extraordinary general meeting of this company was held at Worcester House, Walbrook, E.C., on Wednesday last, for the purpose of considering, and, if thought fit, confirming as a special resolution the resolution which was duly passed at the general meeting held at the same place on March 3rd, for the increasing of the capital of the company. Also for the purpose of considering, and, if thought fit, passing further resolutions having a reference to the mode of issue of such capital.

Mr. J. S. BALFOUR, M.P., presided.

The CHAIRMAN: Well, gentlemen, my first duty is to move a resolution confirming the resolution of the 3rd day of March, 1892, viz., "That the capital of the company be increased to £750,000 by the creation of 25,000 new shares of £10 each, numbered 50,001 to 75,000 inclusive," be and the same is hereby confirmed. I presume that most of the gentlemen who are present to-day were present also at the general meeting which was held on March 3rd, and I need not, therefore, trouble you with any statement at any length as to the reasons which have induced the board to advise that this increase of capital should be made. You are aware that the business of the corporation has increased in a most satisfactory manner, and that we are informed by our works director that the works are quite full, and that there is every reason to anticipate, if we increase the capital, that we shall be able to take some very large and very lucrative contracts. All this was stated at the previous meeting, and the resolution for increasing the capital was unanimously approved at that meeting. I now move that the resolution be confirmed. Mr. Courtenay will second it.

Mr. COURTENAY: I beg to second the resolution.

The resolution was unanimously carried.

The CHAIRMAN: We now come, gentlemen, to the mode of issuing this capital, and the resolution which I have to read is one which has been drawn up by our solicitors, and it is as follows: "That one-half of the said new shares, being those numbered 62,501 to 75,000 inclusive, be allotted and issued by the directors to such persons and at such times as the directors shall think proper, and that the said shares shall be preference shares and shall entitle the holders thereof to a cumulative dividend at the rate of 7 per cent. per annum upon the amount credited as paid up thereon, in priority to any dividend on the ordinary and founders' shares of the company." This proposal has met with the approval of the founders, and that, I think, is probably the best evidence that it is to the advantage of the company. I may state what is present to the mind of the board is that at the present moment we probably shall be able to raise—in fact, we have at the present moment offers to subscribe for a considerable portion of this preference capital—we believe we could raise something of this amount, not probably so much as the whole £125,000 (we do not want to raise so much at present), but £50,000, £60,000, or perhaps £75,000 of preference capital; we could raise that and use it to very great advantage indeed. We believe that the probable claims upon capital, so far as we can foresee, will be met by £125,000 of additional capital. We think when that is raised that by that time the ordinary shares will be at a premium, and we have every reason to believe that we ought to be able, certainly with the business which we have in view, to put a premium if we want to upon any additional capital we may be able to raise by means of ordinary shares, and that premium will go to the reserve fund. You will observe in the resolution that it is stated that these shares shall be issued and allotted by the directors to such persons as the directors may think fit. Of course, the directors consider themselves bound by the terms of the prospectus, and by all the assurances they have ever given to the ordinary shareholders, to offer these shares in the first instance to the ordinary shareholders, so that every ordinary shareholder shall have an opportunity of acquiring some of these preference shares if he thinks so fit. Having carefully considered the matter, the directors firmly believe that this is the most likely mode in which the capital, which is so urgently required, can be raised, and which does not exceed £75,000, but which, I think, will not probably exceed £60,000. We think this the best mode of doing so, and we have taken the best advice we could get from brokers and others in the City of London, and everybody seems to think—and we have evidence that it will be so—that these shares will be taken up by the fact that several of the directors and shareholders have expressed their willingness to subscribe for much more than their proportion. We shall offer the shares we issue to the ordinary shareholders in proportion to their holdings, and if they take them up I think they will secure a very good investment indeed.

Mr. COURTENAY seconded the resolution, which was unanimously carried.

Mr. ROWE: I should like to ask, sir, whether you propose—suppose you issue a part of these shares—to call them entirely up, or to issue the remaining portion? Now, I think it much better to call up each portion as it is issued.

The CHAIRMAN: Hear, hear.

Mr. ROWE: Because the shares will get more valuable if they are called up. There is always great anxiety about shares if a large call can be made upon them, and therefore I should urge—suppose half of them are allotted now—that these should be called up before the whole are issued. As to another matter you have touched upon, I agree that the shareholders should have a chance of taking up this capital.

The CHAIRMAN: Hear, hear.

Dr. DRYSDALE: I suppose we have to vote upon this question upon the supposition, which is perfectly clear from what you have stated, that we may expect greater dividends in the future. I do not say you commit yourselves to that, but I presume you mean that the dividends are likely to be more than they have been, because otherwise it would be a pity to borrow money at 7 per cent. and to give only 6 per cent. That is the only point upon which I desire information.

The CHAIRMAN: Yes, of course; we are large shareholders ourselves—very large holders of ordinary shares. I myself am a very large holder of ordinary shares, and I should not like to see capital put before mine if I did not think that it would be to the benefit of the ordinary shareholders. I cannot conceive with these contracts we have in view and those immediately in hand—if we obtain these orders—I cannot conceive but that there will be a considerable ultimate increase in the dividend to the ordinary shareholders. With regard to the question asked by Mr. Rowe, of course our intention is to call up the shares in full which are issued at present; to make the calls fairly easy, of course, but to call the shares up in full. I agree with Mr. Rowe that it would not be desirable to have preference shares issued with a considerable liability upon them, and looking at the present day and at the present condition of the money market, it is really better to have as little liability on shares as possible. I think prudent investors prefer to make their payments at once, and get rid of the liability. If there are no other questions to be asked, I will put the resolution. Those in favour of the resolution please signify in the usual way. On the contrary. It is carried unanimously. Then the next resolution is:—"That the said preference shares shall also entitle the holders thereof, upon a return of capital of the company, to be repaid the amounts credited as paid thereon, before any payment in respect of capital is made on the ordinary and founders' shares of the company." Mr. Courtenay will second that.

Mr. COURTENAY seconded the resolution, which was unanimously carried.

The CHAIRMAN: That, gentlemen, concludes the business of the meeting, and I thank you very much for your attendance. There will be a confirmatory meeting held on Thursday, April 7th, but it is only *pro forma*, and notice of it will be duly sent out to you.

A vote of thanks to the chairman for presiding closed the proceedings.

Commercial Cable Company.

THE annual meeting of the Commercial Cable Company took place in New York on Monday. The following, says the *Times*, is a synopsis of the report submitted and adopted. The year's earnings amounted to $1,904,717, and the working and other expenses for the year amounted to $819,392, leaving a balance of $1,085,325. Dividends of 1¾ per cent. each were paid for the quarters ending March, June, September, and December, being a total of 7 per cent. on the capital stock of $7,716,000, and absorbing $540,120. The balance of the year's profit, amounting to $545,204, together with $29,796 from the profit and loss account of 1890, aggregating $575,000, was transferred to the reserve fund. On January 15th, 1891, debenture bonds were redeemed to the amount of $600,000, and provision was made for the redemption of $600,000 of bonds on January 15th, 1892.

Gülcher Electric Light and Power Company.—An ordinary general meeting of this company was held on Monday last, but in accordance with a resolution passed by the shareholders, our reporter, along with other representatives of the Press, was asked to withdraw. We are unable, therefore, to give a report of the proceedings.

Mix and Genest.—The report for 1891 states that the turnover increased by 29 per cent. as compared with 1890, and that this result has been largely contributed to by the branch establishments. A dividend of 6 per cent. is proposed, as against 5 per cent. in the previous year.

Wrexham and District Electric Supply Company.—A meeting of this company was to be held yesterday, when it was intended to ask the proprietors to confirm a resolution, reducing the shares from £5 to £1.

Elmore's French Patent Copper Depositing Company, Limited.—The Stock Exchange Committee have ordered the vendor's shares, Nos. 66,751 to 100,000, to be quoted in the official list.

Brush Electrical Engineering Company, Limited.—Issue of 4½ per cent. perpetual debenture stock. Letters of allotment and regret were posted on Wednesday night.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the ten weeks ending March 4th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £33,917; for the week ending March 11th, £2,872 and for the week ending March 18th, £3,181.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (March 17th.)	Closing Quotation. (March 24th.	Business done during week ending (March 24th, 1892.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49½ — 50½	49½ — 50½	50⅝	49½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88½ — 89½	88½ — 89½	89½	88½
2,849,510*l*	Do. do. Deferred	Stock	12 — 12½	11⅞ — 12⅛	12⅛	11⅞
130,000	Brazilian Submarine Telegraph, Limited	10	10¾ — 11¼	11 — 11½	11 1/16	10¾
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛ — 3⅜	3⅛ — 3⅜	3 5/16	3⅛
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2⅛	2 1/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3½ — 4½	3⅝	3½
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	3½	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	7¼ — 8¼	7½ — 8	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	151 —156 xd	151 —156 xd	156	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜ — ½	⅜ — ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6	5½ — 5⅝	5⅝	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜	3⅜	...
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛ — 11⅜	11⅛ — 11⅜	11⅜	11 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 14⅞	14¼ — 15	14 15/16	14¼
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 — 111	108 —111	110¼	109¼
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞ — 15⅛	14⅞ — 15⅛	15⅛	14⅞
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	102 —105	102 —105	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	106 —109	99 —102	108	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	102 —105	103	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5⅜ — 6¼	6 — 6½	6 5/16	6 1/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅞ — 2⅛	1⅞ — 2	2	1⅞
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛ — 3⅛	2⅛ — 3⅛	3 1/16	3
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜ — 1⅝	1⅜ — 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞ — 10⅛	9⅞ — 10⅛	10⅛	10
180,042	Do. do. 6 p. c. Preference	10	14⅞ — 15⅛	14⅞ — 15⅛	15⅛	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18¾ — 19¼	18¾ — 19¼	18¾	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅞ — 8¼	7⅞ — 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½ — 20½	19½ — 20½	20¼	19¾
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —106	104 —107	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42⅜	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	4 15/16	4⅜
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅞ — 3	2⅞ — 3	3	2⅞
10,000	Do. do. fully paid	5	4⅞ — 5	5 — 5⅛	5	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¼ — 9	8¼ — 9	8 1/16	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4¼ — 4½	4¼ — 4½	4½	4¼
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½ — 13½	12½ — 13½	13 5/16	13 1/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½ — 12½	11½ — 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	105 —107	106⅝	106
250,000*l*	Do. (issued at 5 p.m., all paid)	...	79 — 81	79 — 81	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½ — 5½	4½ — 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ⅜	⅛ — ⅜	...	...
9,000	Reuter's Limited	8	7½ — 8	7½ — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼ — 8⅜	8 — 8¼	8½	8 5/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¼ — 7⅜	7¼ — 7⅜	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4 — 4½	4 — 4½	4⅜	4 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45 xd	43 — 45 xd	43⅜	43
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	Ur'' d River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	4 — 5	3½ — 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 — 106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	10¼ — 10⅜	10 — 10½	10½	10
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼ — 6⅜	6 — 6½	6½	6⅜
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4 3/16	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝ — 1⅞	1⅝ — 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅜ — 10¼	10 — 10½	10½	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8¼ — 9½	8½ — 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 — 103	99 — 103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	97 —100	97 —100	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼ — 6⅝	6¼ — 6⅝	6⅝	6 7/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2—2¼.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6⅞—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20¼.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 4½—5.—7 per cent. Preference Shares of £5 (fully paid) 5¼—5⅝.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fullypaid), 5⅞—6.—Liverpool Electric Supply Shares of £5 (fully paid), 4¾—5.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), ⅞—1⅛.—Do. 6 per cent. Preference, 1½—1⅞.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 450—500.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Bawson Ordinary of £5 (£2 10s. paid), ¼—1.—£5 Preference (fully paid), 9¾—9⅞.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 1892).

LEGAL.

Lane-Fox v. Kensington and Knightsbridge Electric Lighting Company.

(*Continued from page* 370.)

TWELFTH DAY, MONDAY, MARCH 14TH, 1892.

In the Chancery Division of the High Court of Justice, on Monday last, before Mr. Justice A. L. Smith (for Mr. Justice Romer), the trial of this action, which is brought by the plaintiff for the usual relief in a patent action, was proceeded with.

Sir HENRY CHRISTOPHER MANCE deposed that he had been associated with telegraphy since 1860. Until recently he had been chairman of the Electrical Construction Corporation. He had read the plaintiff's specifications. In 1878 the meaning of the term "earth" was a vast reservoir or globe with which, if you made contact at two different points, however distant they might be, the resistance offered to the passage of the current was practically nothing. Having read the plaintiff's specification as an engineer, if asked to carry out the directions to use the earth, he should have used the ordinary earth that a telegraphist would have used. Telegraphists generally made their connections by sinking an earth plate.

Mr. JUSTICE A. L. SMITH: It seems to me, from the number of eminent gentlemen who have been called, that "earth" meant any return—soil, insulated or uninsulated wire—but that it was liable to be controlled by the context used in the specification.

Mr. WALLACE: Do you find in the specification any direction to use a continuous metallic current?—Not the slightest.

In cross-examination by Mr. MOULTON, Q.C., WITNESS admitted that it was known in 1878 that the earth operated as a conductor, and that any competent electrician would have known that if he wanted a conductor where the soil was not sufficient he could put one.

Mr. HERBERT WOODVILLE MILLER, examined by Mr. FINLAY, Q.C., said he was the electrical engineer at the Kensington Court station of the defendants' company. He was thoroughly familiar with the processes carried on by the defendant company, and was prepared to explain any detail.

Mr. JUSTICE A. L. SMITH: When did you first become connected with the defendant company?—In 1886. I commenced electric lighting in 1882. I was then at Messrs. Crompton's works.

Mr. FINLAY: Do you think it possible to work with the plaintiff's specification?—Not at all.

Will you state your reasons?—I think the principal reason is that in the specification it was taken for granted that the accumulators were automatic regulators, that is to say, that they could be charged and discharged by increasing or decreasing the electromotive force to a very small extent. Secondly, I believe it is absolutely impossible to send back large currents, such as would be used in a central station supplying a large district, by the use of an earth return.

What do you say with regard to charging and discharging batteries?—I say it is absolutely impossible to charge or discharge batteries with a small increase or decrease of pressure.

What do you mean by small?—I think it is absolutely impossible to charge a battery under from 15 to 25 per cent. pressure. In ordinary practice it is 25 per cent.

Is that the result of your experience, and of experiments you have made to test the question?—Yes.

WITNESS then gave particulars and tables of his experiments, which he said proved what he had just stated. The use of pressure in a cell when charging, he went on to say, was due to chemical action, and would therefore be the same, whether the cell was large or small. In charging the cell there was the resistance in the cell itself, and also the resistance due to chemical action resulting from the current passing through the cell. That resistance would not be overcome by increasing the area of the cells. The greatest difference between charging and discharging an accumulator—that was to say, from the time it was considered empty, namely, when it gave a voltage of 1·8, up to the time when it was filled up to its proper amount, namely, 2·8 volts—was a maximum variation of 35 per cent. Such a variation as that would not be allowed in practice; at the highest the lamps would be smashed, at the lowest the light would not be brilliant enough.

How do you get over this difficulty?—We have to use an arrangement of switches to get over this variation, so that when the pressure of the cells rises, due to them being charged, we are able to move the switch to which the feeders are connected down to a cell where the pressure is at the normal amount. When the pressure drops, we are able to move switches, so as to introduce more cells, and thus keep up the voltage.

Without such an arrangement can the thing work practically?—No.

How do you know when the cells are full?—We have a recording meter in series with each of the batteries we use, and we continue charging batteries until the reading of the meter shows us the batteries are full.

How does the meter show it?—In ampère hours. We use the same meter for the discharge.

WITNESS proceeded to say that the capacity of each of their batteries was 1,000 ampère hours. There was a waste between charging and discharging, and unless something extra was put in to make up the waste each day, the capacity of the battery would gradually decrease until nothing was got out of it at all, because more was being taken out than was being put in. In time the whole battery would be ruined if it were not charged up to its full capacity. If you only put into the battery each day exactly what you took out, the capacity of the battery would gradually decrease, because of the loss which takes place between each charging and discharging. If the battery were charged to its full capacity there would not be the same trouble.

Why not?—Because you have made up for the loss which takes place during the operation of charging or discharging, and the batteries therefore come back to their proper condition. If you do not charge fully, you do not perform the chemical action necessary for retaining the capacity of the battery.

Do you think that secondary batteries, placed as the plaintiff proposes, would regulate the light automatically?—I do not think so, because of the rise and fall of pressure due to charging and discharging the batteries.

What do you use secondary batteries for?—As reservoirs of electricity during the time we do not require to run the machinery.

How do you regulate?—By altering the speed of the engines and dynamos.

WITNESS produced a diagram which he said showed that it was absolutely necessary to have some form of regulation—that the secondary batteries would not by themselves automatically regulate the pressure. At their station, 2 per cent. each way in the variation of the lamps was allowed. If the variation was greater than that they had complaints as to the unsteadiness of the lamps.

Cross-examined by Mr. MOULTON: If a large number of lamps were lighted, a certain amount of electromotive force would come out of the batteries, the effect of which would be to partially supply the current and prevent the lamps being as much affected as they otherwise would be. He said that no current would come out of the battery if the potential was the same as the mains, unless there was a large variation, such as 300 or 400 lamps turned on.

No current would come out of the battery if the mains fell to one volt below what it was standing at?—No.

Mr. MOULTON?—You have stated yourself that a difference of one volt would make it flow back or forward.

Mr. JUSTICE A. L. SMITH: Have you ever stated that a fall of one volt in the main would cause current to come out?—I do not remember stating that.

Mr. MOULTON: I put it to you that you made that statement at the time of the inspection by the plaintiff's witnesses?—I do not remember any such statement; most likely I did not make it.

Are you prepared to say you did not?—As far as I can remember I did not.

WITNESS then admitted that secondary batteries minimised the effect of pressure in the mains independent of the way in which the pressure was produced. It was not the fact that you could get more into a battery without the bubbles coming off freely by using a small current. He could get 600 to 1,000 ampère hours into the defendants' batteries without causing the bubbles to come off freely. He did not think the whole of the bubbles were waste of energy—much of them was. The last portion was put in at much greater cost than the first, and a less proportion of it was got back again. Stronger acid was used than in Planté's time, but it was not that which rendered it necessary to bubble the defendants' batteries. The gasing of the defendants' batteries was not due to the peculiarity of their batteries. Planté directed them to stop charging the batteries when the bubbles came off freely. Planté indicated that as the maximum charge, because it was waste to go beyond. He said seriously they could send 200 ampères through their batteries at the same pressure as 20 ampères.

Do you say the pressure makes no difference whether 20 ampères or 200 ampères come out of the batteries?—That is quite different.

WITNESS then admitted that a larger proportion of energy could be got out of a battery if it were not charged to an excessive amount. He said it would not do to make the batteries bubble every week, but admitted that he had not tried this. If the cells were not filled every day they got bad. In the case of the diagram put in to show that the batteries did not regulate, there was no dynamo on. The defendants' mains were always connected to the batteries by means of the discharging switch, and the effect of switching another on was to reinforce the batteries that were discharging. The defendants had always had a switch which altered the number of cells being charged. The effect of the switches was to reinforce the potential when the cells were being discharged, and to cut out cells which were being charged when they showed signs of being full. If the defendants used Lane-Fox's system, he daresay a great many other companies did. They had always had a charging switch and a discharging switch, but they had not always used them in the same way; at one time they had one switch to do the two operations. The change was made about October, 1890.

Mr. JUSTICE A. L. SMITH: Why did you do that?

WITNESS: At the Kensington Court Station we found it much more convenient to have both switches quite independent. We have never altered the switches at Queen's Gate Station. When he said that variations of pressure could not be made by increasing the size of the plates, he meant that increasing the size of the plates did not necessarily mean that you had to use less pressure for charging it with the same current.

In re-examination by Mr. FINLAY, WITNESS explained that the same operation in charging and discharging was performed by the one-switch arrrangement and the two-switch arrangement.

Mr. ROBERT STEWART ERSKINE, examined by Mr. WALLACE, said he had been secretary of the defendant company since the end of 1886. In 1881 he was in the service of the Brush Company, in the department of Mr. Lane-Fox. He remembered an exhibit prepared for the Paris Exhibition. As far as he could understand, it was intended that any available return, such as iron work, was to be used. Insulated mains were put up, both lead and return, and Mr. Lane-Fox said it was a great waste of money, No batteries were used there or in Mr. Lane-Fox's exhibit at the Crystal Palace in 1882. At that time Mr. Lane-Fox was principally engaged on his lamp. 60 volts were used at the Crystal Palace, and 45 at Paris. Four sets of batteries, coupled up in parallel, were used at the Vienna Opera

House, 50 in each set. The steam plant used was that belonging to the Opera House. The batteries were used to store up the current, the engines not running whilst the performances were on. He did not remember any switches being used for putting on the cells, but there was a large switchboard, the design of which he could not remember, which enabled them to put on cells either for charging or discharging. There might have been switches to enable one or more cells to be put on.

Mr. Justice A. L. Smith: It was not automatic?—We charged up and then discharged independently.

Mr. James Swinburne, an electrical engineer, who has been engaged in practical electric lighting for ten years, and is a member of the Council of Electrical Engineers, said that he had examined the defendants' system, and had read the plaintiff's specification. He pointed out the points of resemblance and of difference between the plaintiff's and the defendants' systems, in the same way as previous witnesses had done. The secondary batteries as used by the defendants, he said, would save flickering to a certain extent, but they were not used for that purpose, and would not stop flickering if used as described in the plaintiff's specification. In 1878, "the earth" used electrically was the soil, though by a stretch it was sometimes used in laboratories to include insulated conductors. In parallel incandescent lighting, it was quite impossible to use the soil return. A battery would not charge and discharge usefully with such a small variation of pressure as the plaintiff indicated. Planté batteries would work as flicker regulators under certain conditions, if you did not want them for storing. They could not be used for storing and regulating at the same time. If they were used for storing, they must every day or so be completely charged up, and that needed a high pressure; the useful part of the discharge was at a much lower pressure. It was necessary to charge cells fully to get the whole of the coating converted in active material, as well as for their health. He did not think charging cells up to the bubbling point once a week would keep them healthy. Increasing the size of the cell area of Planté's cells would not do away with the necessity for increased pressure in charging. More pressure was wanted to drive a heavy current than a light one at some parts of the curve. He had tested an earth plate put by Mr. Lane-Fox in a garden at Teddington, and with a pressure of 60 volts turned on he got 20 ampères. To carry out Mr. Lane-Fox's system, earth plates of a fabulous size would be required. He had made a calculation that it would take between 26 acres and four square miles to take 1,000 ampères with one volt at each earth plate. 1,000 ampères would carry about 3,000 lamps of 8 candles. A current of 1,000 ampères would eat away 10 tons of iron in a year at the spots where the soil against the pipes was damp.

Cross-examined by Mr. Moulton, Witness said that an electrician in 1878, knowing he could not use the earth, would have recourse to an insulated conductor. No competent electrician would attempt to make an earth plate of the size he had mentioned.

Mr. Justice A. L. Smith: I have already said that my view is, that in 1878 a competent engineer would have read "earth" and "the earth" as any conductor that would suit his purpose. That is apart from the context. That may help you, or it may not.

Cross-examined by Mr. Moulton, Witness said that Mr. Lane-Fox had his pressure constant from time to time, but not from place to place. The constancy of from place to place which the defendants had was obtained by their feeders, which did away with the plaintiff's system and substituted another.

In all cases it is the pressure that determines the amount that goes through the battery, and it requires a higher pressure to drive a large current through than a small one?—Certainly.

Working on the plateau a small increase of pressure makes a great difference in the amount of current that goes in?—Yes.

Witness then said that Planté's cells of 1878 were not permanent; they leaked, and their coatings came off. In Planté's book there was mention of cells of some 20 square feet. He agreed that charging the batteries to bubbling point was for their health, and that there was a waste of energy in the last part that was got in. More bubbling was needed with the present form of cells than with the old Planté cells.

At this stage the further hearing of the case was adjourned for the day.

Thirteenth Day, March 15th, 1892.

In further cross-examination by Mr. Moulton, Q.C., Mr. James Swinburne said it was customary to use switches for the purpose of switching more or less cells on to influence the current.

Taking it as equilibrium, I put it to you that with a decrease, say, of 1 per cent., a considerable charge will come out of the battery?—It will for a very short time.

And a rise will cause a considerable current to go in?—Also for a very short time.

It will continue until it causes a rise of electromotive force in the battery, which checks it?—Yes.

Mr. Finlay: For how long?—A few seconds.

It has been suggested that feeders are shown in Lane-Fox's patent. Is there a word of that in the specification?—No, there is not.

Mr. Thomas Shillito, electrician to the Marquis of Salisbury, examined by Mr. Wallace, said the installation at Hatfield House commenced in 1879, and he had had charge of it since the commencement. The dynamo was placed at the saw mill, about a mile and a-half from the house, and was driven by water from the river. The current was carried to the house by insulated leads hung on poles between the saw mill and the house. It was insulated by the ordinary porcelain insulators. The return wire was attached at each end to the water pipe that ran from the house to the dynamo. The wire was carried from the negative side of the dynamo, twisted round the water pipe, and soldered to it. After the current passed through the lamps the return wire was carried to the water pipe near the house, and secured in a similar manner. For some time that worked very well, but the whole time they used it it was very erratic, the wire very often being eaten in two near the water pipe, and the connection thus broken entirely. They had to search for the fault, and after finding it they had to repair it. There were very great objections to that system, because the house being full of gas pipes as well as water pipes, everything was affected by it, and until he devised a switch for it, the workmen engaged in the house would sometimes get a severe shock from touching one of the gas pipes.

Mr. Justice Smith: What point are we on now?

Mr. Wallace: We are showing that the direction given by Mr Lane-Fox in his specification is misleading, and that the patent would be bad for want of utility.

Examination continued: They put in an insulated return, similar to the other, for the whole distance. Short circuiting was very dangerous, the main danger being the fear of sparking and fire. When they first began, they ran something like 20 ampères through it. In 1881 they had four dynamos instead of one.

Mr. Justice Smith: What system did you put up?—We had the Jablochkoff, with arc lamps.

Mr. Wallace: That was the second system described by the Attorney-General in his opening.

Examination continued: In his opinion such a system as that described by Mr. Lane-Fox would not work in any large installation. They employed a few batteries, but simply to light his lordship's study when the machine was not running. They got a constant current at Hatfield House, and that was secured by having a first-rate steam engine, well regulated.

In cross examination, Witness said the Gramme machine was between 500 and 600 volts. The shocks from alternating currents were more severe than from a direct current.

Would you like to touch any portion of insulated wire of 800 volts?—If well insulated.

Do you suggest that telegraph wires are not insulated?—They are hung on insulators.

If you had a system insulated all over with 800 volts alternating, and any one touched a bare portion of that conductor, would he not have received a rather severe shock?—Certainly he would.

Mr. Oscar Doesner, electrical engineer, in the employ of Messrs. Siemens Bros. & Co., said he had been with the firm since 1866, and had had experience of electric lighting since 1877. His first experience was putting up the electric light at the Lizard lighthouse. In 1878 he put up the electric lighting at Lord Armstrong's house at Craigside. Arc lamps were used, and at first he tried to use the earth as the return. The dynamo was worked by water at a distance of a mile or a mile and a half from the house. There was a current of 15 ampères, and the voltage was 50. The outgoing conductor was bare copper wire, insulated overhead on posts. A water pipe going down the lane was used instead of an earth plate. He connected with insulated wire and soldered round the pipe, and on the dynamo he did the same, and connected with a water turbine. That did not work, the dynamo did not excite, because the circuit was not complete, and the resistance between the two pipes was so great that the current could not pass through to complete the circuit. After that he put another metallic return wire, and then it worked all right. The series dynamo was, he believed, the only one known in 1878. The shunt wound dynamo was later than that, and the compound wound was a combination of the shunt and the series.

In cross-examination, Witness said that separately excited dynamos were known at that time, but he considered them to a certain extent series dynamos.

Prof. Alexander Kennedy, examined by Mr. Wallace, said he was chief engineer of the Westminster Electric Lighting Corporation.

Mr. Wallace here explained that this was one of the company's interested in the result of this law suit.

Examination continued: In the ordinary course of working he had made certain tests of batteries, but not for the purposes of this action, the tests being made in the course of last year. The test was to fully charge the battery, and then for the battery to discharge itself. The voltage for 50 cells at the end of the previous charging was 129 volts or 2·58 per cell. He started the discharge about one hour after the charge was finished. The pressure in the cells before discharge was 106·5 or 2·13 per cell.

Mr. Justice Smith: You charged the cell with voltage of 129, how did the cell remain charged for an hour without anything happening?—It was not being discharged.

How do you discharge?—By making an electrical connection through something.

Examination continued: When charging was going on the pressure was very much higher than the pressure that remained in the cells immediately afterwards. The pressure did not stop at 129 for 50 cells; it fell when they stopped pushing the current in, and in the case he mentioned it fell to 106·5, and stood at that until he began to take something out. Five minutes after he commenced discharging it dropped rapidly, and after that it continued to drop more or less until the end. It was discharged at about the rate of 90, with considerable variations, and then at a lower rate to the end. When left to itself without charge or discharge, the battery stood at about 100 volts. The conclusions he drew from that were:—First, that the charging was to go on upon a very much higher level than the discharging; secondly, the pressure fell in that case 6 per cent. during the course of the discharge; and thirdly, the discharge line was extremely uneven, caused by certain irregularities in the resistance it was discharging through. A battery without switches could not be used as a regulator; there would be too much or too little charge, and the cells would rapidly be destroyed.

Mr. Bernard Drake, senior partner in the firm of Drake and Gorman, electrical engineers, said he had paid considerable attention

to secondary batteries since 1883, and the result of his experience was that accumulators of lead must be charged at 2·5 volts per cell, to enable the plates to last at all. The effect of not charging up to the point was that they got local action between the lead conductor and the oxides, which would cause the plates to buckle and become useless. In his opinion the failure of secondary cells arose from insufficient charging.

You have told us that the batteries regulate the kick of a gas engine. The effect of the irregularity of the gas engine is to cause a variation of potential in the mains?—Yes.

That is equalised, as you have told us, by the batteries?—It is not equalised; it is made less perceptible to the eye. Unless the cell is well charged it has little tendency that way; it would have it to a less extent than if it were fully charged. The batteries will help to equalise the pressure for a few seconds—much less than a minute.

Does not your curve show that with a variation of 1 per cent. you get nearly the normal current into the battery?—Not for a minute; it begins falling the instant you put it on.

Batteries are not relied upon for bearing the whole weight of a discharge from an installation during its busy times?—For central stations, no; for private houses, yes.

The real substantial part of the supply comes from the dynamos?—Yes.

Your installations are in private houses in which the lamps are actually run off the batteries, are they not?—In a good proportion of them we change in the day time, and work off at night.

In very few you run the lamps, batteries, and dynamos at the same time?—I should think we have 50 installations where we run the three together.

Steam engines are not perfect, and the belt coming off, and such like accidents would affect the regularity of the current?—Quite so.

In 1878 Planté had worked for many years with his batteries. Does not he announce that his batteries have an efficiency of 90 per cent.?—I do not remember. I will take it from you.

He made one of 37 square feet or 4 square metres in surface?—Yes.

In 1878 it was not known that you had to bubble Planté's plates to keep them in health?—It was not known then, or known at all until I showed it.

You are, I believe, one of the persons subscribing to the defence of this action?—Yes.

Re-examined by Mr. FINLAY: The kick from the gas engine was a momentary affair, and had no relation to the effect produced by turning on or off a number of lamps. Where proper steam plant was employed, that momentary kick had not to be dealt with.

Mr. FRANK KING, examined by Mr. WALLACE, said he was the manager of the E.P.S. Company, whose works were at Millbank. He had been connected with the E.P.S. Company since 1886, and had been connected with electric lighting since 1883. He was a manufacturer of electrical apparatus in 1875. His company had made 38,000 experiments in charging and discharging secondary batteries. All those chargings and dischargings showed one common result: that the pressure in charging rises in 50 cells from 100 volts to 125 volts, and that the pressure in discharging the same number of cells would be from 99½ to 94. In practice, you had to get 105 before you could get a current into your batteries of any useful amount. At that voltage the battery would be destroyed, because the chemical action proceeding in the battery would go on at a faster rate than the renovating action of the charge. His company contracted to keep batteries in repair.

Mr. JUSTICE A. L. SMITH: What do you say is the voltage you have to be constantly applying to batteries to keep them in a healthy state?

WITNESS: The installation must contain a provision for raising the electromotive force over 125 volts.

Mr. JUSTICE A. L. SMITH: Without switches, could you keep your batteries in health?—Not without danger to your lamps.

Examined further by Mr. WALLACE, WITNESS gave details of experiments bearing out what he had stated. He understood Lane-Fox's patent to be for the use of secondary batteries without switching arrangements, a dynamo having a capacity represented by the charging current, and a lamp circuit requiring a larger amount of current than the dynamo alone could render. According to the number of lamps which constituted the load, the pressure would fall from 110 volts down to 98, with the result that there would be marked irregularity in the amount of light, far and away too great for any commercial system.

Cross-examined by the ATTORNEY-GENERAL, WITNESS said that if no secondary batteries were on at all, with the dynamo producing a constant current of 80 ampères, the variation might have been 3 volts.

Supposing you are running that kind of engine without secondary batteries, would not you break your lamps down?—You would not have the 80 ampères.

Supposing you had half the lamps on, could you produce the 80 ampères then?—Certainly not, without the secondary batteries.

Would not the removal of secondary batteries tend to raise the voltage if your engine was maintaining its output?—Yes.

If the lamps are suddenly turned off, the engine running so as to produce 80 ampères, will you give me any figures upon which you say that the voltage cannot rise above 3 volts?—I have given them to you; the resistance of the armature settles it.

Will you pledge your word that the rise of voltage will not be as high as 120 volts or more?—Assuming the mains to have no resistance, I will pledge my word it does not do so.

Supposing you had two batteries in parallel, what then would be the variation?—About three-quarters of this.

I put it to you, it would be one-half?—No.

If you had three batteries coupled in parallel?—It would be one-eighth.

Do you swear there will be more variation with secondary batteries than without them?—Yes.

How were your secondary batteries coupled?—Between the main and the return wire.

Would not that increase the fluctuations of voltage?—Certainly.

Why do you keep secondary batteries coupled between the main and the return wire?—For the purpose of charging.

The way you kept the pressure at 80 ampères was by having the steam engine running at constant speed, and making the dynamo revolve at a constant speed?—Yes.

Adjourned for the day.

FOURTEENTH DAY, WEDNESDAY, MARCH 16TH.

Mr. KING was further cross-examined by the ATTORNEY-GENERAL.

Do you think any cell, or 50 cells, charged with a current of 108 volts rising to 109, if in proper condition, unless it was already full, would only let in 2 ampère hours in five hours?—If the cell is in good condition as regards charge that state of things might occur.

If you do keep your charging current at only 108, and you only get in 2 ampère hours in five hours, it must mean that the cell is nearly full?—It must mean the cell is three-quarters full or in bad condition.

Are not your directions to your customers to charge the cells occasionally—once a fortnight or once a week—to keep them in good condition?—The directions to the customers are to cause gas to be evolved if possible daily, and certainly at as frequent intervals as the cells will permit. The extra hour carries the voltage to 125.

Who was the previous manager of the E.P.S. Company?—Mr. Drake.

Had you manufactured secondary batteries before you went to the E.P.S.?—Yes.

Were they pasted plates?—I prefer not to answer that question.

Since you have been at the E.P.S. you have been working on the pasted plates only?—Yes; but I have experimented with many others.

Have you ever experimented with Planté pure and simple?—No.

Have you superintended installations and supplied dynamos, engines, secondary batteries, mains, and lights?—Yes.

Did you issue directions for working such installations?—Yes. We put up a printed card. We do not put up installations now; we only supply secondary batteries.

Were not those secondary batteries invariably coupled between the main and the return wire?—Through the regulating switch, yes.

Mr. JUSTICE A. L. SMITH: What did you put up secondary batteries for?

WITNESS: The installations were mostly put up in private houses, where it is impracticable to keep a man in attendance on the engine during the whole time the lights may be required, consequently the secondary batteries are charged, and the lights drawn off from the batteries alone as required.

Have you not provided in the case of their wanting say, 40 ampères, that the engine should run 30, and 10 should come out of the batteries?—Yes.

The switches are used so, that when you are charging, you shall not have an undue voltage sent into your lamp circuit or main?—Certainly.

And when discharging you shall have sufficient voltage sent with your mains or lamps?—Yes.

Have not you repeatedly told your customers it was an advantage to the light to use secondary batteries as a fly-wheel or check when the engine was running?—In the case of a gas engine installation, certainly.

And if in a steam engine the engineer was careless, and allowed the pressure of the steam to pop up and down, or the engine to run unequally, have not you told them it would have the same effect?—I have not.

Has not that been put forward by your people as an advantage of the secondary batteries in your installations?—I should say not.

The only difference would be that steam would be less liable to run unequally than gas?—Yes.

If the steam ran irregularly, would not the secondary batteries have the same relative effect?—It is a matter of degree entirely.

When did you first discover that a high charge tended to keep batteries in good health?—I, in common with others, discovered this about 1885. Mr. Drake has the credit of making it public.

Re-examined by Sir HORACE DAVEY, Q.C., WITNESS said that his company supplied batteries to all comers, and the customers were recommended to apply the switching apparatus. In his opinion it was absolutely essential to have a system of switches for the purpose of throwing cells in and out, in order to have a workable system of electric lighting. It was desirable for the proper working of the system to have the storage batteries coupled up between the main and the return wire. The system could be worked by putting the batteries at the far end, if some one were on the watch. To a slight degree the injurious effect of pulsations of the engine was corrected by the secondary batteries, but not to an extent which met the purpose without mechanical devices. Directions were given by his company to their customers not to let the secondary batteries discharge too rapidly for the purpose of regulating the dynamos; not the lamps.

Sir HORACE DAVEY: This is the conclusion of our evidence.

The ATTORNEY-GENERAL: I ask leave to call evidence on one or two points.

Mr. JUSTICE A. L. SMITH: What do you want to prove?

The ATTORNEY-GENERAL: That, in fact, from actual observation in an installation working exactly as these defendants' does—that is to say, with steam engine, secondary batteries, and mains—there is from moment to moment a regulating or keeping of a constant pressure. They allege that the secondary batteries do not, in fact, regulate.

Mr. Justice A. L. Smith: The evidence given of what another machine does would not be evidence. You must prove what the defendants do. You do not want more than you have got from Sir Frederick Bramwell.

The Attorney-General: Another point is with regard to a document put in by Mr. Crompton, showing a cell not receiving a charge. I think it is to a great extent met by the evidence of Mr. King.

Mr. Justice A. L. Smith: I think it was a nearly full cell. You have evidence to that effect.

Mr. Finlay, Q.C., then proceeded to sum up the case on behalf of the defendants. He proposed, he said, to call attention to what the defendants submitted was the effect of the evidence. The observations he had to make would group themselves round three heads. First, with regard to the process described in the specification, the defendants said that was unworkable. Secondly, they said that there was no patent for regulation, that if there were it would be bad, and not the subject matter of a patent. Thirdly, the defendants said that there was no infringement. Although these were the three heads around which he proposed to group his observations, it would be found that there were various parts of the case which bore upon more than one head. The first observation he should make on the general nature of the case was that the peculiarity of it was that they were in 1892 discussing a patent taken out in 1878, and that that patent had, without the most material alterations, never been put in practice. That was an observation of very considerable potency in estimating the value of the evidence for the plaintiff. What they were now asked to do was to carry themselves back from 1892, and to appreciate what would be the state of mind of an electrical workman of competent knowledge in 1878. He submitted that a patent so stale as this was not one in favour of which there was any particular presumption. One would have expected (if this patent really did contain the valuable information his friends relied on) that it would have been heard of a great deal sooner. He submitted that no adequate explanation had been given for all that delay, and that the true reason was to be found in the considerations to which he was going to direct attention—to the effect that the patent was really one which was not worth anything. The first point on which observations arose as to the unworkable nature of this invention related to the use of the words "the earth" in the specification. He submitted that the meaning of the term "the earth," as employed in the specification, was simply a question of the plain ordinary meaning of the English language. All the electricians in the world might come and give evidence as to technical meanings, and so forth, but he submitted that nothing would serve his friends' purpose beyond demonstration that to an electrician a direction to use the soil of the earth, in the words of the specification, would mean a direction to use something else. His first point was that the patent included nothing else but the earth, and that, therefore, the defendants had not infringed. His second point was that, for the purpose of unworkability of the earth, it was enough for his argument that the words of the patent included the soil of the earth. His friends could not say that this patent warned anybody off the soil of the earth, with earth plates, or gas and water pipes, therefore they were met with this unsurmountable difficulty, that one way which the patentee had indicated of carrying out his invention was unworkable. This, on the authority of the Aniline Dye case, was fatal to the plaintiff. From the evidence, it was clear that the plaintiff's system was for the application to a large system of electric lighting, by means of a number of batteries scattered about the system. The evidence had clearly established that the earth would not work with such a system of incandescent lighting, on account of the enormous size of the earth plates that would be, wanted. Prof. Perry said there was no difficulty in having the earth plates, and indicated the size that would be required; but Mr. Lane-Fox, corroborated by practical men in a manner which put the point beyond doubt, said he entirely disagreed with Prof. Perry, and the fact that not one single instance of the application of the earth return could be produced during all these years, spoke volumes in favour of the defendants' contention. His (Mr. Finlay's) next point as regarded the unworkability of the plaintiff's system, was that if gas and water pipes were employed as directed, the pipes would be destroyed by electrolysis.

Mr. Justice A. L. Smith: The plaintiff does not claim gas and water pipes absolutely; he says it would be convenient to use them.

Mr. Finlay said that it had been shown that it was impracticable to use anything but an insulated conductor. The defendants had proved that the plaintiff's system would not work without a system of switches, because if you tried to charge without switches you must get up to a point where the lamps would be broken. Of course, the defendants did not claim to have invented switches; their invention was the application of these switches to the cells. The plaintiff said that switches were not necessary; but the evidence showed that they were. His friends had contended that these switching arrangements were not necessary, that the difficulty would be got over by making the cells sufficiently large in conducting area, and that adequate directions for this were given in the plaintiff's specification. But the only thing that the plaintiff pointed out was that cells of large conducting surfaces were to be employed, and the plaintiff's witness had construed this to mean cells with five times the ordinary conducting surface, which had been shown to be impracticable and insufficient. The result was that the plaintiff's directions were worthless for the purpose for which they were given. Experiments, and the results of the experience of the actual workman had shown that using the cells in the way described in the plaintiff's specification would destroy them. How had the plaintiff attempted to meet that? They had given no evidence saying that the process they desired to put forward as the one way of working this specification—the way a practical workman would have had recourse to—had been successfully pursued. Their whole case was left to rest on a mass of speculative evidence given by eminent electricians who could not say, as a matter of practical experience, that what they said could be done had been done.

Mr. Graham said that the plaintiff's experts had made such experiments as Mr. Finlay referred to, and that the Attorney-General had desired to give evidence of their result.

Mr. Finlay pointed out that the Attorney-General had made no such application. On this point, he said, judgment must go against the plaintiff by default. The plaintiff's patent, if used in the way his friends said it was to be used, would be a patent for destroying secondary batteries. So far from the intelligent electrical workman naturally applying switches, he respectfully submitted that the patent distinctly warned him off that. The one feature of the patent was that it was automatic in its working, and the application of switches was inconsistent with this, its distinguishing feature. A patent was not good which made calls upon the workman who carried it out the amount of experiment and skill which the devising of any system necessary to counteract this destruction of the cells would require. On the questions of what this patent was for, and whether, if it were for regulation, it would be a good patent, he submitted that the plaintiff's specification did not show a patent for regulating at all; that it was a patent merely for the use of these secondary batteries as storers of electrical energy in combination with the system of distribution described. There was not a single word in the specification about regulating except by the regulator which had been disclaimed.

Mr. Justice A. L. Smith: How about "constant"?

Mr. Finlay submitted that the idea of the secondary batteries regulating the electromotive force was strange to the provisional specification.

Mr. Justice A. L. Smith: It is in the word "constant" if it is there at all. What I understand is that where you claim in a provisional specification for A and B, you cannot in the final increase that to A, B and C.

Mr. Finlay said that was so, and gave his Lordship a list of authorities bearing on that point. The only ground, he said, on which it was attempted to support this patent was that it was a patent for regulating and counteracting the flicker in the lamps. If the final specification was in conformity with the provisional, it did not claim regulation; if it did not claim regulation it varied from the provisional, and was therefore bad. He submitted that the fair reading of the final was that it was in conformity with the provisional, and that it claimed secondary batteries only for storage.

Mr. Justice A. L. Smith: Assuming the final was in conformity with the provisional, why am I not to read the meaning of the plaintiff's patent to be for keeping the lamps constant?

Mr. Finlay said secondary batteries were not mentioned by themselves for the purpose of keeping the electromotive force in the mains constant; they were only mentioned in connection with the employment of generating machines. The plaintiff attempted, in construing the patent as disclaimed, to employ words in a different sense from that in which they were introduced in the provisional specification, which could not be done. There was not a word in the specification as disclaimed about regulating.

Mr. Justice A. L. Smith: He says I claim for keeping it constant, and that constancy does prevent some sort of flicker.

Mr. Finlay said that the plaintiff did not say that that effect was produced by the secondary batteries. What the plaintiff said was that they served as a kind of reservoir for the electricity, and that to keep the electromotive force constant it was desirable to have several generating machines and also a number of reservoir batteries, as before explained; and that was really inconsistent with the idea that the constancy was counteracting the flicker because the secondary batteries were there. What was the amount of regulation these batteries would bring about? After a great deal of evidence on the point, the truth was quite manifest. There would be some amount of regulation inherent in any apparatus of this kind, as one would expect. With a gas engine there was a momentary flicker at the interval between the beats. If the secondary batteries were full they would act so as to prevent the momentary flicker. That really, he submitted, was the extent of the counteraction of the flicker of which these secondary batteries were capable. The secondary batteries must be full, and the flicker must be purely momentary, if the secondary batteries were to regulate effectually. The defendants dealt with the rise and fall in the voltage owing to the lamps being turned off and on, not by these secondary batteries, but by regulating at the dynamo.

Mr. Justice A. L. Smith pointed out that Sir Frederick Bramwell said, "I think that secondary batteries would tend largely to correct rise and fall at the lamps when lamps are turned on and off."

Mr. Finlay: I accept that.

Mr. Justice A. L. Smith: All the other gentlemen minimise it as much as they can, but they all come to the scratch when they come to be cross-examined by the Attorney-General.

Mr. Finlay: What Sir Frederick Bramwell says is, that they would have that tendency, but that, as a matter of fact, the defendants do not use them for that purpose.

Mr. Justice A. L. Smith: That is on the question of infringement. You have proved that these secondary batteries are not universally used. I think the balance of evidence is that the defendants do not use secondary batteries for regulating so much as for storage purposes.

Mr. Finlay: I submit that, leaving out of account the fact that we do not use secondary batteries for regulating, if you take the whole evidence it comes to this, that they will take up a momentary flicker.

Mr. Justice A. L. Smith: Does not it come to this, that the plaintiff has put his case too high as to the controlling effect of secondary batteries?

Mr. Finlay said it was more than that. He said that all that the secondary batteries would counteract was the momentary flicker, such as that of a gas engine, and the defendants did not use gas engines.

The evidence showed that when you put on or off a number of lamps the flicker was different and greater, and would not be counteracted by the use of secondary batteries. When a number of lamps were turned on the change of voltage was not momentary, but lasted for some time. If the load were increased there would be a fall in the voltage, and until that fall took place there was nothing to operate on the secondary batteries. When the fall of energy had taken place (say, of 2 volts), it might bring out from the secondary battery a current which would counteract it; but that counteraction would be only for a few seconds, and when that state of things had passed away, you would be exactly where you were before. This was the effect of the evidence of Prof. Kennedy and Mr. Drake. His next point was that even if his friends had established that they had a valid claim for regulation in the patent, and even if their process would regulate, he submitted that there was no novelty or invention in the plaintiff's specification which would support a patent. The plaintiff's claim was for a combination—the employment, as described, of secondary batteries as reservoirs, of electricity in combination with a mode or system of distribution, such as was before described.

MR. JUSTICE A. L. SMITH: How about distribution?

MR. FINLAY said the plaintiff claimed to use secondary batteries in connection with a system of distribution which he did not claim in itself; the plaintiff did not claim the distribution as anything new, that having been struck out. What the plaintiff claimed was putting side by side with a system of distribution Planté's batteries as reservoirs for electricity. That was merely one use of Planté's batteries, and if that were good subject matter of a patent, Mr. Lane-Fox could have excluded Planté himself from using his own batteries for a purpose for which they were adapted. Even if he claimed secondary batteries for regulation, that would be a claim for one valuable property inherent in Planté's system. The law was that an inventor could not be shut out from any possible use of his patent unless the new inventor had made some invention either for rendering it applicable to a new purpose, or a combination which showed some ingenuity, novelty, and invention. There was absolutely nothing in the plaintiff's specification except the juxtaposition of Planté's batteries with a system of distribution for electric lighting for which he did not now (and could not now) make any claim. Beyond this, he submitted that Clarke had anticipated the plaintiff's patent. The objection of his friends to Clarke's patent was that it was a patent for producing momentary effects. It having been shown that the regulating effect of secondary batteries was also momentary, that objection applied with equal force to the plaintiff's patent. On the question of infringement, the learned counsel said that according to the plaintiff's claim, as now put forward, the plaintiff used batteries always connected with the dynamo, batteries which were dotted about the system in different parts of the district, and whose action was automatic. The defendants' batteries, on the other hand, were employed in taking up the current not required for the lamps, and giving it out when there was a draft. The defendants had their batteries not always connected with the dynamos; they did not have them dotted about the system in different parts of the district on the far side of the lamps—they had them between the dynamos and the lamps; they did not act automatically at all. He submitted that the whole process, as carried on by the defendants, was radically different from the plaintiff's.

MR. JUSTICE A. L. SMITH: It all depends whether Mr. Lane-Fox can read into his patent secondary batteries plus switches. You seem to me at times to be working Lane-Fox with switches.

MR. FINLAY: I submit we are not working it, for this reason, that we do not regulate by secondary batteries at all.

MR. JUSTICE A. L. SMITH: The evidence is you use them for storing; but if the evidence be that storing necessarily gives regulation, which the plaintiff has properly claimed for secondary batteries plus switches, I cannot see why you are not infringing.

MR. FINLAY: We say that we do not use them for regulating purposes, and that the only regulation of which they would be capable, would be that momentary regulation which we do not want, because we do not use gas engines. If "the earth" be a feature in the plaintiff's combination (as I submit it is), manifestly we do not use that.

MR. JUSTICE A. L. SMITH: That depends on the construction of the specification.

MR. FINLAY agreed. If, he said, the defendants were right in saying that the earth was a part of the plaintiff's system of distribution, then the defendants had not infringed, because their mode of distribution was different. In conclusion, he had only to point out that the plaintiff's system, if it would work, would only secure constancy from time to time, not from place to place; that was to say, the plaintiff wanted the pressure to be constant at all times, but you would not have the same pressure in all parts of the system owing to loss from resistance in the mains; whereas, according to the defendants' system, you had constancy from time to time by the regulation of the dynamo and by the use of switches when the store of electricity was being drawn upon, and you had constancy from place to place by the use of the feeders which carried the electromotive force at a voltage at the station higher than that required at the point of delivery.

The further hearing of the case was adjourned until Friday next, when the Attorney-General will reply on behalf of the plaintiff.

(To be continued.)

Mavor and Coulson v. Grierson.—In the Court of Session, Edinburgh, on Friday, Lord Low gave judgment in an action brought by Mavor and Coulson, electric light engineers and contractors, 56, George Square, Glasgow, against Henry Grierson, Craigend Park, Liberton, for payment of £169 0s. 7d., as the balance of an account for lighting the defender's house with electricity. The defender said he had made payments amounting to £1,302 14s. 2d., and that owing to the non-fulfilment of the contract he was entitled to a deduction from the account sued for. Lord Low said the account amounted to £1,471 14s. 9d., and the defender had paid £1,302 14s. 2d. The defender's payments, so far as they had been made, had been paid promptly and without any unnecessary delay. He, however, refused to pay the balance sued for until the accounts were gone over and checked. He asked Mr. Mavor to meet him and go over the accounts, but before that meeting took place the pursuers somewhat prematurely raised this action. The defender admitted a balance of £50, but he said the remainder should be disallowed, as being over-charged. The defender consulted the pursuers as to lighting his house with electricity, and in January, 1891, they sent him a specification. In their letter to him they said they preferred putting private house installations on time and material, as it was difficult to estimate accurately the cost of wiring. The estimate was, however, made up, and came to £1,100 as the cost of lighting the house with 130 lamps of 16 candle-power, the price to be exclusive of all mason work and foundations for engines and dynamo fittings. The specification gave particulars of the dynamo and 130 lamps of 16 candle-power each. It appeared that the pursuers had previously offered £1,000 as the probable cost, and on January 22nd the defender wrote stating that he hoped there would not be any additional work. The pursuers replied that they had added an amount to cover contingencies, but they would carry out the work as economically as possible, but did not bind him to particulars. His Lordship thought the case was only one of an approximate estimate. The defender further said he was to get 150 lamps, but only about 130 were supplied. The pursuers said that was so, but there was extra expense in wirings. Considering the evidence as a whole, his Lordship was of opinion that there were more than 130 points at which lamps had been or might be fitted. It was admitted, however, that in the billiard room there was a light of 150 candle-power, for which some extra wiring must have been necessary. In his Lordship's opinion £36 fell to be deducted from the amount sued for in respect of the twenty additional lights. His Lordship also allowed a deduction of £4 16s. 5d. in connection with the cost of fitting up the engine and boilers, and gave decree for the sum of £128 4s. 2d.

An "Infant" Partner.—In the case of Shaw *v.* Stocks, which came before Mr. Justice Stirling in the Chancery Division last week, Mr. Parker, instructed by Mr. J. Percy Chadwick, applied on behalf of the plaintiff to the Court for the appointment of a receiver for a firm of electrical engineers. He said that bankruptcy proceedings were pending against one of the partners, and the other partner was an infant, and under the age of twenty-one. There was really, therefore, no responsible person in the business, and under the circumstances he asked the Court to order that some one should take possession of the electrical apparatus and machinery. The infant himself had not got possession of the business.

MR. JUSTICE STIRLING: You had better ask for a sale?

MR. PARKER said he thought perhaps he had, and he asked his Lordship to say that service of a writ on the infant was good service. The writ had been served on the infant and not on his guardian.

HIS LORDSHIP, in granting application for a receiver, said he thought that if an infant had capacity to be a partner, he had capacity to receive service of writs.

Edison and Swan Electric Lighting Company v. Sharp and Kent.—The case of the Edison and Swan Electric Lighting Company *v.* Sharp and Kent, last Friday, came before Mr. Justice Stirling sitting in the Chancery Division of the High Court. This was a motion for an injunction with regard to the use of a certain patent, and the learned counsel in the case stated that the parties had agreed to treat the motion as the trial of the action, the defendants agreeing to submit to a perpetual injunction, and pay a specified sum for costs.

NEW PATENTS—1892.

3,919. "Improved method of repairing incandescent lamps." W. S. RAWSON and WOODHOUSE AND RAWSON UNITED, LTD. Dated February 29th.

3,951. "An improved telephonic transmitter diaphragm." J. S. LEWIS. Dated March 1st.

3,970. "Electro-magnetic machines." B. J. B. MILLS. (Communicated by R. Lundell, United States.) Dated March 1st. *(Complete.)*

3,971. "Improvements in power transmitting devices, especially applicable to the electrical propulsion of vehicles." B. J. B. MILLS. (Communicated by E. H. Johnson, United States.) Dated March 1st. *(Complete.)*

3,991. "Improvements in electrical call and indicating apparatus." G. R. NUNN. Dated March 1st.

3,996. "Improvements in galvanic electric adhesive plasters." W. P. THOMPSON. (Communicated by J. W. Shults, United States.) Dated March 1st. *(Complete.)*

3,997. "Improvements in reflectors for electric lamps." C. H. SMEETON and H. PAGE. Dated March 1st.

4,003. "Improvements in electro-magnetic tools." W. S. RAWSON, W. P. GALLWEY and WOODHOUSE AND RAWSON UNITED, LTD. Dated March 1st.

4,010. "Improvements in telephones." W. C. LOCKWOOD. Dated March 1st. (*Complete.*)

4,015. "Improvements in electrical devices for stopping and starting horses." H. H. LAKE. (Communicated by the Holson Electric Harness and Supply Company, United States.) Dated March 1st. (*Complete.*)

4,017. "Improvements in electric measuring instruments." H. H. LAKE. (Communicated by E. Weston, United States.) Dated March 1st. (*Complete.*)

4,025. "An improved means of effecting electrical communication through the medium of a clock or similar apparatus." W. H. MILLER. Dated March 1st.

4,068. "Improvements in telephones." J. B. S. BOOTH and E. J. FALCONER. Dated March 2nd.

4,097. "An improvement in the construction of electric arc lamps." E. C. RUSSELL. Dated March 2nd.

4,103. "Electro-deposition of aluminium on metals." R. GOODWIN. Dated March 2nd.

4,111. "An improvement in electro-magnetic time and date-stamping machines." J. M. GLOVER. Dated March 2nd.

4,112. "An improvement in electro-magnetic postal, cancelling, time and date-stamping machine." J. M. GLOVER. Dated March 2nd.

4,113. "Improvements in electro-magnetic time and date stamps." J. M. GLOVER. Dated March 2nd.

4,125. "Improvements in electrical circuit arrangements and apparatus for telegraph message signalling." F. T. HOLLINS. Dated March 2nd.

4,134. "Improvements in electrical visual signalling apparatus." C. E. KELWAY. Dated March 2nd.

4,152. "Improvements in electro-therapeutic apparatus." W. J. HERDMAN. Dated March 2nd. (*Complete.*)

4,154. "Improvements in electric batteries." E. VIARENGO. Dated March 2nd.

4,157. "Improvements in shades for electric glow lamps." H. W. TAYLOR. Dated March 2nd.

4,158. "Improvements connected with electric circuits for varying, regulating, or controlling the pressure of electric currents therein." H. EDMUNDS. Dated March 2nd.

4,161. "Improvements in regulating the feed of arc lamps." F. J. TAYLOR. Dated March 2nd.

4,185. "A new or improved automatic portable galvanic battery." P. STIENS. Dated March 3rd. (*Complete.*)

4,186. "An improved slow speed dynamo." S. J. ROLLASON. Dated March 3rd.

4,190. "Improvements in electrical batteries. F. M. A. LAURENT-CELY and E. FINOT. Dated March 3rd.

4,192. "Improvements in, and relating to, electric meters." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY and A. SOAMES. Dated March 3rd.

4,244. "Improvements in ships' telegraphs." H. ENDALL. Dated March 3rd. (*Complete.*)

4,247. "An electrical cut-out." H. S. KEATING. Dated March 3rd.

4,248. "Improvements in arc electric lamps." J. BROCKIE. Dated March 3rd.

4,258. "Improvements in the wearing parts of dynamo-electric machinery." W. L. SPENCE. Dated March 4th.

4,276. "Improvements in electrical testing instruments." R. W. PAUL and F. KNOWL. Dated March 4th.

4,277. "An electric motor." A. E. PATTERSON. Dated March 4th.

4,294. "Cross's electrical illuminations for clocks, &c." W. CROSS. Dated March 4th.

4,311. "Improvements in dynamos." W. S. SMITH and H. J. GARNETT. Dated March 4th.

4,316. "Improvements in electric welding and in apparatus therefor." E. G. HOFFMANN. Dated March 4th.

4,320. "Improvements in apparatus for regulating the arc in electric arc lamps." A. W. MONEY and H. NASH. Dated March 4th.

4,341. "Improvements in the methods of driving electric railway trains." W. L. SPENCE. Dated March 5th.

4,356. "Improvements in electric measuring instruments." W. T. GOOLDEN and S. EVERSHED. Dated March 5th.

4,403. "An electric switch." W. K. PARTINGTON. Dated March 5th.

4,414. "Improvements in and relating to dynamo-electric machines." C. COERPER. Dated March 5th. (*Complete.*)

4,416. "Improvements in electric switches." W. H. WESTON and G. W. WESTON. Dated March 5th. (*Complete.*)

4,427. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (Communicated by the Western Electric Company, United States.) Dated March 5th.

4,428. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (Communicated by the Western Electric Company, United States.) Dated March 5th.

4,429. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (Communicated by the Western Electric Company, United States.) Dated March 5th.

4,456. "A process for electro-plating." R. W. JAMES. (Communicated by G. E. Gale, United States.) Dated March 7th.

4,457. "An apparatus for cleaning the hulls of vessels and other objects for electro-plating." R. W. JAMES. (Communicated by G. E. Gale, United States.) Dated March 7th.

4,458. "An electrode for electro-plating." R. W. JAMES. (Communicated by G. E. Gale, United States. Dated March 7th.

4,464. "An automatic electric loom and card-cutting machine." H. B. LEE and J. C. COOK. Dated March 7th.

4,494. "Improvements in electro-magnetic solenoid apparatus." F. V. ANDERSEN. Dated March 7th.

4,523. "Regulating sockets or holders for incandescent electric lamps and other translating devices." THE RIES ELECTRIC SPECIALTY Co. Dated March 8th. (*Complete.*)

4,524. "Improvements in controlling the levers of railway signal interlocking apparatus by the application of electricity." W. F. BURLEIGH. Dated March 8th. (*Complete.*)

4,543. "Electrical measuring instruments." G. WILSON. Dated March 8th.

4,576. "Improvements in secondary batteries." J. V. SHERRIN. Dated March 8th.

4,578. "Improvements in and relating to applying carbon filaments to electric lamps." A. C. CAREY. Dated March 8th. (*Complete.*)

4,579. "Improvements in galvanic batteries and battery liquids." S. A. ROSENTHAL and J. V. SHERRIN. Dated March 8th.

4,586. "Improvements in magnetic separators for ore and similar material." C. T. THOMPSON and R. H. SANDERS. Dated March 8th. (*Complete.*)

4,610. "Improvements in electric gas-lighting burners." G. F. PINKHAM. Dated March 8th. (*Complete.*)

4,617. "Improvements in electrical attachments for pianos." F. A. FELDKAMP, J. SCHOENHAAR and E. E. LEHR. Dated March 8th. (*Complete.*)

4,691. "Improvements in secondary electric clocks." E. SCHWEIZER. Dated March 9th. (*Complete.*)

4,709. "An improved method of and means for electric wiring." R. F. YORKE. Dated March 9th.

4,758. "Improvements in the method and means of obtaining electricity." W. BOGGETT. Dated March 10th.

4,764. "Improvements in insulators for electric wires." H. H. LAKE. (Communicated by C. N. Hammond, United States.) Dated March 10th. (*Complete.*)

4,768. "Improvements in electric batteries." S. W. MAQUAY. Dated March 10th.

4,773. "Improvements in the manufacture of electrical conductors." G. F. REDFERN. (Communicated by S. Bergmann, Germany.) Dated March 10th. (*Complete.*)

4,779. "A improvement connected with electric arc lamps." J. J. RATHBONE and J. HOUGHTON. Dated March 10th.

4,816. "Improvements in electrical cables." W. FAIRWEATHER. (Communicated by E. F. Phillips, United States.) Dated March 11th. (*Complete.*)

4,820. "Improvements in primary batteries." L. MERCKY. Dated March 11th.

4,841. "Improvements in the methods of driving electric railway trains." W. L. SPENCE. Dated March 11th.

4,889. "Improvements in methods of alternating current distribution." W. F. TAYLOR. Dated March 12th.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1890.

9,861. "Improvements in electrical storage batteries." A. J. BOULT. (A communication from D. Tommasi and C. Therye, of Paris.) Dated June 25th. 8d. The main feature of this electrical storage battery is that its electrodes are made in the shape of tubes instead of being formed of plates. 4 claims.

13,791. "Improvements relating to compositions and devices for use in the manufacture of filaments for incandescent electric lamps." H. H. LAKE. (Communicated from abroad by V. M. Hobby, of America.) Dated September 2nd. 6d. Comprises a composition of matter to be used for carbonising the filament. The composition consists of the following ingredients, combined in the proportions stated, viz.:—Carbon, sugar, liquid mucilage, liquid india ink, each one ounce. 4 claims.

15,413. "An arc electric lamp." T. B. GRANT. Dated September 29th. 6d. Claim:—In an arc electric lamp, in combination with a solenoid coil in the lamp circuit a tubular iron core, and above it an iron tube resting on the core at one side, so arranged that when the solenoid is excited the carbon holder is clamped by the tube and moves with the core, substantially as described.

18,890. "Improvements in automatic telephone connectors." J. Y. JOHNSON. (Communicated from abroad by the Automatic Electric Exchange Company, of America.) Dated November 21st. 2s. 9d. Relates to automatic telephone connectors of that class in which successive electrical impulses derived from a battery are employed to effect the step by step movement of a suitable bar of metal capable of becoming a part of the circuit of the said battery, along a certain pathway in which metallic plates or pins are placed in a regular series, each of which leads by a wire to the earth at a special point more or less remote from the locality of the said bar of metal and its pathway, to the end that any given number of successive electrical impulses shall always determine the contact of the said bar of metal with the same metallic pin or plate in continuity by a wire with a remote ground, and the possible passage of the said electrical current to the said ground by way of the circuit thus established. 9 claims.

19,191. "Improvements in and relating to electric railways and tramways." M. WHELESS and S. E. WHEATLEY. Dated November 25th. 1s. 1d. Consists in an electric tramway conduit system; in magnetic switches for such systems; in the peculiar arrangement of the armature and the

connections between the power line and the working conductor sections so as to make a larger break when the working conductor section is cut out; in an improved cut-out on the tramway cars whereby a cut-out for each of the line sections is dispensed with, said cut-out operating to break the local circuit as soon as the latter has performed its function of closing the working conductor section with the power line; in a novel construction of double trolley; in the combining of the switch and rheostat levers so that one moves the other, and so that by one movement the local circuit is closed, and the rheostat operated; in an auxiliary circuit closer adapted to close the battery circuit in case a non-conductive obstruction should intervene between the car wheel and track, said auxiliary circuit closer being adapted for use in case the ordinary circuit closer should fail in its operation by reason of such obstruction; in an insulated brake whereby the shunting of the current through the brake is avoided, and lastly, the invention consists in a novel construction of conduits for the cable or wire of underground electric tramways. 21 claims.

21,045. "Apparatus for armouring insulated electrical conductors." F. WALTON. Dated December 24th. 6d. Relates to apparatus whereby an electrical conducting wire or group of wires covered with insulating material, has formed upon it armour by coiling helically on it a continuous strip of metal corrugated in such a manner that the successive convolutions interlock with each other, thus forming a flexible tube enclosing the insulated conductor or conductors. 1 claim.

THE RIES REGULATING LAMP SOCKETS.

BY W. J. HAMMER.*

MUCH has been said of late in reference to the utility of the reaction-coil principle when applied to the regulation of independent incandescent electric lamps operated by alternating currents, as exemplified in the very ingenious, but up to the present, imperfectly understood, regulating sockets recently devised by Mr. Elias E. Ries of Baltimore, and in view of the remarkable claims for this invention and the interest which it has attracted in electrical circles, the writer takes pleasure in bringing the matter before the public through the courteous permission of Mr. Ries who has extended to him facilities for making a thorough investigation of its merits. The socket was first shown publicly at the Montreal Convention of the National Electric Light Association, and it is doubtful if any feature of the exhibition at that time attracted more general interest.

Many attempts have been made to produce a satisfactory and economical method of turning down incandescent lamps. The earliest experiments were made by Mr. Edison and others, in which carbon rods, plates, coils of German silver, platinum, iridium and other metals were introduced in the series with the lamp, thus causing much of the energy cut out of the lamp to be dissipated as heat, and none of these methods has proved efficient or of commercial value.

Lamps were also constructed containing two or more carbons which could be connected in series or multiple to vary the candle-power, and a lamp invented by the writer, many years ago, contained a number of carbons of various candle-power, which could be separately introduced into the circuit to give any degree of light desired.

Inventors have also endeavoured to construct an economical device for controlling the light without the introduction of resistance, as the value of such a means of regulating the incandescent light has always been appreciated, and one of the principal claims of gas engineers is that the incandescent lamp could not be turned up and down, certainly not with the efficiency which existed in the gas system. Mr. Philip Diehl has presented the writer with a complete set of the experimental steps in his alternating current lamps which show a very interesting stepping-stone in this direction.

Before proceeding further let me say a few words upon the principle of the reaction coil which has been applied in various ways by Thomson, Shallenberger, Ries and others, and referred to in the works of Fleming, Hopkinson and others. A reaction coil of the most simple type is constructed of one coil of a conductor wound around a magnetisable core; probably the simplest form employed commercially is the ordinary spark coil used in electric gas lighting. A direct current passed through such a coil magnetises the core and sets up lines of force which maintain the same direction so long as the current is continued; there is a slight heat also produced in the coil due to its ohmic resistance. Naturally, reversing the direction of the current reverses the polarity of the magnetised core. It does more than this, however. This reversal of current and consequent disturbance of the magnetic field produces practically a transformer with but one coil in which appears the impressed E.M.F. and the counter E.M.F.; the counter E.M.F. retards the primary current through the coil, producing the "choking effect" as it is called. In employing a continuous or direct current the counter E.M.F. is produced only at the instant of closing of the circuit or reversing the direction of the current, but with rapid alternating current the counter E.M.F. becomes as constant as the impressed E.M.F. of the primary current, and in the Ries socket the ratio of these may be varied, thus controlling the candle-power of each light independently and without resistance, and, as shown by Fleming and others, with an infinitesimal loss.

When the difference between the two E.M.Fs. is greatest, as determined by the position of the regulating key, the light is at its maximum, and when this difference is such that the two E.M.Fs. nearly approximate each other, the filament glows at its minimum point of light. One of these E.M.Fs. being variable with respect to the other, it will thus be seen that lamps of any desired voltage less than that of the supply circuit can be safely burned at their normal candle-power, and that standard lamps of any given voltage or resistance that are supplied with a normal E.M.F. of, say, 50 or 55 volts, can be burned at any degree of brilliancy required all the way from a barely perceptible glow up to their maximum candle-power. The most remarkable part of this method of electric lighting is its extremely high efficiency and the self-contained simplicity of the apparatus by which it is carried out. The writer has in his possession sockets of this character in which the two E.M.Fs. so nearly balance each other as to extinguish the light without even the necessity of opening the lamp circuit, the amount of energy consumed in maintaining this balance being so slight as to be measurable with only the most sensitive instrument. I have personally placed lamps in series with a sensitive ampèremeter and varied the current from 3½ ampères to $\frac{1}{10}$th of an ampère as perfectly as gas is turned up and down, the ampèremeter indicating the variation in current precisely as if it were a fluid or gas which was being turned on or off.

The writer has had the privilege of witnessing some ingenious and beautiful effects produced by Mr. Ries which show the facility with which this socket lends itself to modifications, adapting it to special requirements. For example, one is enabled to operate a 110-volt Edison lamp on a 55-volt Westinghouse alternating circuit, or to operate a 55-volt lamp on a 110-volt circuit, and at the same time to produce all the variations in light from zero up to full candle-power. All this, it should be noted, is produced with practically no loss of current and entirely by the reaction of the current upon itself; no moving apparatus or outside connections whatever, other than the usual circuit adjustments on ordinary lamp sockets being employed.

The Ries socket comprises an enclosing shell of neat design, and but slightly larger than the well-known types of "make-and-break" sockets now in use, and contains a small counter E.M.F. generator or reaction coil, or choking coil of peculiar construction, which, however, may be of any desired type so long as the general conditions to which it owes its high efficiency are adhered to. This coil consists of a small, thoroughly laminated, closed iron core built up of numerous rings of specially prepared iron, the whole being compressed, taped and wound at one operation with a special silk-insulated cable containing a number of separately insulated copper wires of different diameter, varying according to the maximum current to be carried by each, the ends of these wires, after the cable is wound, being connected in series with each other by contact pins arranged in the path of an arm attached to the operating key. The interior connections are such that when the socket is wired up more or less of the wire composing the coil is in series with the lamp filament, according to the position of the operating key, and the length of wire thus included determines the amount of counter E.M.F. generated. Or, to express it in another way, by cutting out turns of the coil the self-induction is lessened and more current is allowed to flow through the wire to the lamp. The light is divided by this socket into seven different stages, and the potential difference between each contact pin being but one-seventh

* *Electrical Engineer*, New York.

that of the total difference of potential on the mains, the flashing at these points is very slight, no snap action or other complicated make-and-break mechanism being employed. The entire arrangement is one of great simplicity and compactness, requiring no more attention or knowledge in operation than the turning on and off of an ordinary gas burner, which in this respect it closely resembles.

When the lamp is burning at full candle-power, practically all of the coil sections are cut out; that is to say, when lamps of the normal voltage of the supply circuit are used. Usually, however, it is advisable to employ lamps of somewhat lower voltage, so that if for any reason the pressure on the circuit falls below its normal, the lamp may be turned up so as to still give its maximum candle-power, a feature not at present attainable with the ordinary type of sockets in general use. When the full amount of light is not needed, the counter E.M.F. generated is increased by the cutting in of additional coil sections, thereby reducing the flow of current through the lamp and causing the latter to glow at a lesser degree of brilliancy, and at the same time materially reducing the strain upon the lamp filament. The winding of the socket is so arranged that when the light is turned down to its lowest stage the filament is just visible in the dark, so as to readily enable one to locate the position of the lamp upon entering a room and to turn it up to the desired point without having to first feel around for it among the electrolier or other fixtures of which it forms part. By the use of this socket one may have some lights in a room burning at low brilliancy and others at a lower degree of incandescence, thus distributing the light exactly where it may be wanted, instead of being compelled to burn the lamps full on when but little light is needed.

The saving in current that this socket is capable of effecting is almost beyond the belief of one who has not tried it, and actually surpasses everything that has yet been claimed for it in this direction. The writer has had occasion to thoroughly investigate this point recently, and has found that a 25 C.P. 50-volt lamp, which consumed 75 watts when burning in one of these sockets at full candle-power, consumed, together with the socket, just 3 watts, or only *one twenty-fifth* of the total energy, when burning at a low degree of incandescence equal to that produced by a net potential difference of 10 volts at the lamp terminals. This means that it is possible to burn 25 lamps at a visible degree of incandescence by means of this socket with the same amount of electrical energy that a single lamp would consume burning at its normal candle-power. Of course, the light given by the lamp at this point, while sufficient to render the filament itself visible at a distance, was altogether too small for the purpose of affording outside illumination, and therefore this cannot be taken as a criterion of the average consumption of current in practice, which would be very much higher, especially as the lamps are usually burned at nearly or full candle-power by the consumer when in actual service for furnishing light; the intermediate stages being used for the most part only for all-night service in sleeping apartments and other places where under the existing condition of things, the incandescent light, if used at all, would be turned off altogether. The writer believes the Ries regulating socket marks a radically new departure in the method of controlling the incandescent electric light.

CORRESPONDENCE.

Electric Construction Corporation.

It is extraordinary that the directors, before issuing their proposal for increasing the capital of the Corporation by £250,000—one half of it in seven per cent. preference shares—should not have condescended to notice or to offer to the shareholders some explanation of the very unfavourable features in the last balance sheet. A letter which I addressed to the chairman on the 12th of January, pointing them out, remains unanswered, and has not even met with the courtesy of an acknowledgment.

1. The amount of "Sales and Work" for 1889-90 was £222,734; for last year, 1890-1, the amount was £160,036; showing a decrease of £62,698. This falling off is tremendous, even allowing for the transfer, four months before the closing of the accounts, of the Millwall Works to another company. The chairman of the annual meeting, while silent as to this immense decrease, positively boasted of the large amount of work that had been turned out!

2. The "Expenses and Cost of Production" rose from 77¾ per cent. in the former period, to 81 per cent. last year.

3. Although there was such a great decrease in the amount of "Sales and Work," the head office expenses increased to the extent of £419 on the year and amounted to £11,423. The concentration of the works might have been expected to reduce these expenses. Moreover, Mr. J. S. Balfour, the vice-chairman of the Corporation, had, at the previous annual meeting, admitted that they were very heavy, and said the board intended to overhaul the whole of them, with the view of seeing if economies could be effected. The result of this effort at retrenchment is not calculated to inspire confidence in the management, especially when it is borne in mind that there was also an increase of about £10,000 in "Other Expenses."

4. The working of the Corporation's own business—apart from profits on licenses, patents, subsidiary companies, &c.—which showed a profit of £26,110 for the first period, 1889-90, showed a loss of £2,402 for last year, 1890-1.

Why do not the directors frankly take the shareholders into their confidence by full explanations on all these points? Nothing is more damaging than a suspicion that the policy of suppression of facts is being pursued. If the directors were alive to this and to the necessity of "mending or ending" the London management, the shares of the Corporation would not now be standing at a discount of 35 to 40 per cent. below their par value, and any requisite capital would be readily provided by the shareholders without resorting to the issue of seven per cent. preference shares.

A. W. Thomas.

March 16th 1892.

Some Experimental Investigations of Alternate Currents.

In the authorised abstract of the discussion (Institution of Electrical Engineers) published in your last week's issue, I am represented as having said precisely the opposite of what the transcript of the shorthand writer's notes correctly reports me to have said. I remarked that of two transformers, both giving 95 per cent. efficiency at full load and having the iron to copper losses as 3 to 1 and 1 to 3 when so loaded, the 24-hour efficiency taken on a central station mid-winter curve, similar to that of the Kensington and Knightsbridge Company, comes out at 76·3 per cent. and 87·9 per cent. respectively, thus showing the effect produced by varying the iron and copper losses even when the sum of the two at full load remains the same. I have not worked out the efficiencies for the summer load, and am therefore unable to give the mean for the year, but it will be readily seen that taken over twelve months, with the lowering of both efficiencies there will be manifested a still greater advantage on the side of the transformer having the greater copper loss.

I take this opportunity of protesting against the present custom of publishing a scrappy report of the Institution proceedings as an "authorised" abstract. It has always been most unsatisfactory.

W. B. Esson.

March 22nd, 1892.

[We have often protested against these authorised abstracts, our last protest being on February 26th, but we must rest content with them or nothing.—Eds. Elec. Rev.]

Electric Traction.

Referring to your criticisms on "Electrical Traction and its Financial Aspect," I am of opinion that the paper would have been needlessly lengthened, and the discussion therefore shortened, by giving details of working expenditure (which have been already so fully published in the technical journals) to "engineers of the present day who are looking for detailed items."

And as regards the "commercial question" my "*unhappy*" condition appeals to your sense of justice to suggest to you, that though I have taken a "hypothetical case of three miles of tramway," I have not given "hypothetical figures."

Stephen Sellon.

March 22nd, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

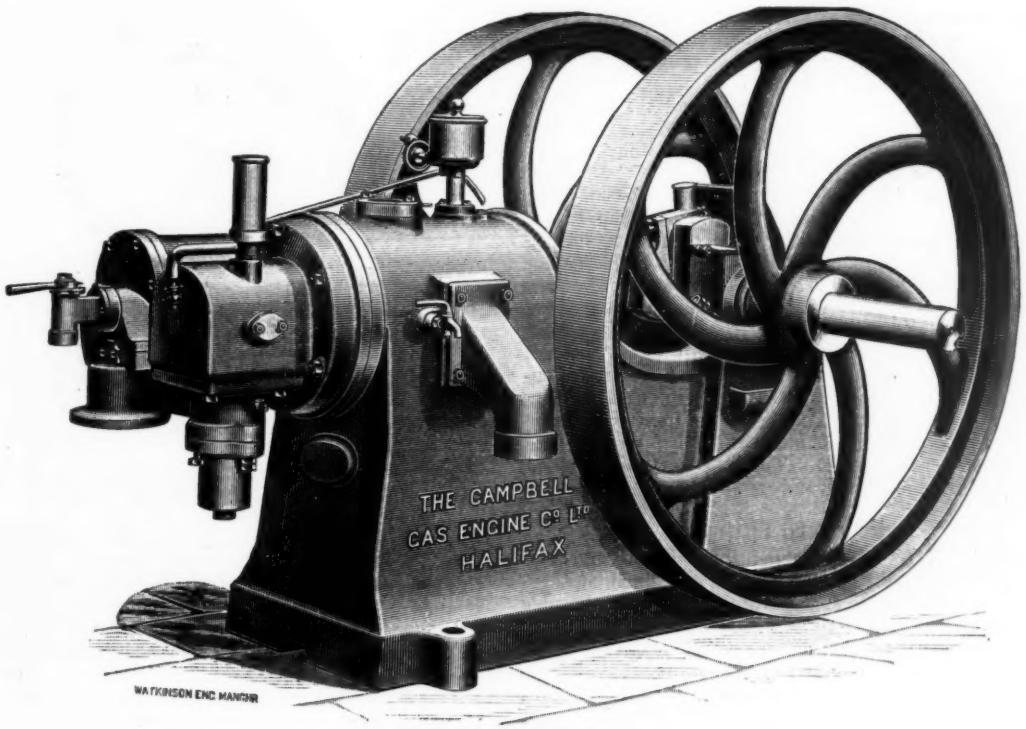
Boilers and Engines.

We have not previously referred to the boilers at the exhibition. These are placed in a room off the machinery room, and consist of a battery of eight steel locomotive boilers, made by Davey, Paxman & Co., which are used for supplying the steam for driving the engines used in the exhibition. The boilers contain a total heating surface of about 5,640 square feet; they are provided with steel fire-boxes, and are made in the best known and most modern manner, being well stayed and tested by hydraulic pressure to 250 lbs. per square inch for a working pressure of 140 lbs. A steel steam receiver runs the entire length of the boilers, connected to each by a separate stop valve, so that either or any of the boilers can be shut off immediately if necessary. The object of the receiver is to give dry steam to the engines, and to turn back to the boilers any condensed steam. The pumps for feeding the boilers are made by Mr. A. G. Mumford, of Colchester, and the injectors are of Messrs. Gresham and Craven's manufacture. The boiler fittings are asbestos packed, and the water gauges are fitted with protecting shields. There is, also, a Paxman's patent new type water tube boiler in the boiler house. The boiler contains about 1,572 square feet of heating surface. This boiler is made on a new principle, in which it automatically separates any water in the steam. It contains several new features, principally as to the circulation and separation of steam from water. Furthermore, it is made in sections, which are very readily removable, and are much more handy for repairs than is common to many of the types of boilers. The joint for the headers for getting at the tubes is a patent of Paxman & Plane's, a pattern of which can be seen at the stand. It is a very simple, but serviceable joint, and is expected to come into general use, not only in this type of boiler, but for manholes and mudholes, &c., in other kinds of boilers.

The joint possesses the advantage of being quickly broken and re-made, and when made it is perfectly tight. The greater the pressure inside, the tighter the joint, as the pressure assists in keeping the joint tight. It is very lasting, and the metallic core is said to be almost indestructible, and will last for many years.

Paxman's patent single acting compound steam engine, new type, fitted with Paxman's patent automatic expansion gear and adjustable high speed governors is shown.

There are also a double cylinder horizontal fixed steam engine, Class A, to indicate 40 H.P., fitted with Paxman's patent automatic expansion gear and adjustable high speed governors, and triple expansion Windsor vertical engine with high pressure cylinder 12 inches diameter, intermediate cylinder 18¾ inches diameter, low pressure cylinder 30 inches diameter respectively, and 18 inches stroke, with dynamo combined, and driving direct. The dynamo, which has been illustrated and described by us, is made by Messrs. Johnson and Phillips.



CAMPBELL GAS ENGINE.

Campbell Gas Engine.

Our illustration shows the latest development of this engine. It is, we are informed, the outcome of nine years' testing and experimenting, and the makers believe that their experience is summed up in the engine shown. It gives 9 actual or brake H.P. when running at 250 revolutions per minute. The gas consumption is stated to be 18 cubic feet per indicated H.P. per hour with coal gas of 17 candle-power and 1½ inches pressure. The cylinder jacket, engine bed and pedestal are made in one casting, herein differing from the ordinary practice of making each part separately and bolting them together. The engine bed has been prolonged underneath the cylinder with the purpose of reducing the overhang of the cylinders. By this means much vibration is avoided. In the larger sizes of this engine the overhang of cylinder is entirely abolished, the bed being prolonged to the end of the cylinder. In the Otto cycle type of engine this cannot be done on account of the room required underneath the cylinder for working the various valves by cam levers. A further feature of the Campbell gas engine is that there is an ignition at every revolution of the crank when required. Should the load driven by the engine only be a

light one, the governor automatically cuts off the gas and air supply. Should it, however, be necessary for absolutely steady driving, the admission valve for the gas and air can be set in the new type of engine to take in the explosive mixture in only sufficient quantities at every revolution to drive the work required; *i.e.*, if only 4 H.P. actual is required from the 9 that the engine can do, the admission valve can be set to do this work and yet have an ignition at every revolution of the crank. Of course, if 6 or 8 actual H.P. is required, it can be done in the same manner as above. Another new feature is making the valves so that they can be easily removed and cleaned without breaking a joint. In this case no putty or asbestos is required to keep them tight, a desideratum highly to be desired, for these articles have a knack of getting out of their joints, and clogging them fast. Seven of these engines, of different sizes, are working at the Crystal Palace Electrical Exhibition doing work of various kinds. The makers are the Campbell Gas Engine Company, Halifax.

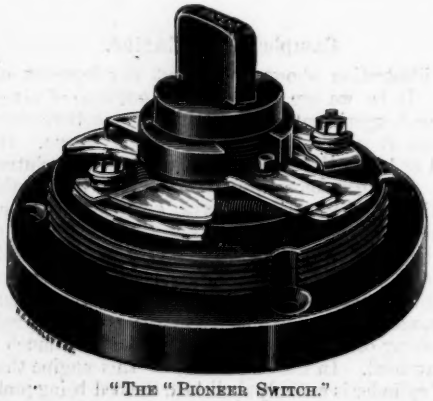
Search Lights.

On Messrs. Crompton's stand is a 24-inch Admiralty pattern projector of 30,000 candle-power nominal, mounted on base, and arranged for a vertical and horizontal adjustment. It has a powerful mirror, and throws a very fine beam. The greatest novelty about this projector is that it is fitted with an automatic lamp of an entirely new type. Projectors as a rule, are worked by hand, and the two other search lights in use in the building are of the hand type of regulation. The Crompton-Pochin lamp, which is now shown for the first time, is of horizontal pattern, and this, again, is an innovation in search lights, as the vertical form of lamp, which leans slightly backward, has, up to the present, been almost universally used. The regulating mechanism of the lamp is different to that employed for ordinary arc lamps, while it is so sensitive that it feeds every few seconds. There is very little flicker in the light, and the steady beam is continually projected. No doubt a lamp such as this would be appreciated on a ship passing through the Suez Canal, where the usual form of lamp requires constant attendance. The projector is fixed on a conning tower in the centre of the Palace, almost in front of the great organ, and plays upon the fountain which has recently been opened in the centre transept. The lamp takes about 65 or 70 volts and from 50 to 100 amperes.

Switches and Fittings.

At Mr. A. P. Lundberg's stand there is, among other fittings of later date, one of Lundberg's original switches on wood base, with spiral spring working above the movable contact plate. This pattern was invented in 1883, and the one shown is one of the first dozen made.

This switch (now obsolete as far as manufacture is concerned) was illustrated and described in the Review, August 16th, 1884, and was the pioneer of all electric light



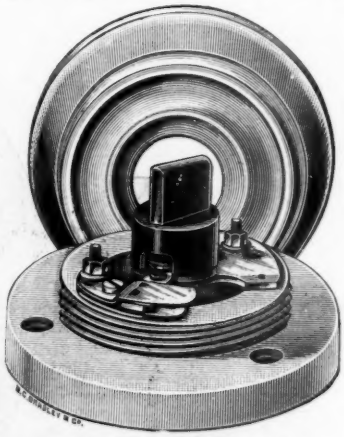
"The "Pioneer Switch."

switches employing a spiral spring in any form for producing a quick break of the circuit. It held the market for some years, and on examination will be found to compare favourably in workmanship, action, and contact, with many patterns now in the market.

There are many varieties of switches in decorated and plain porcelain, slate, &c., shown of the "Pioneer" type, with similar action to the "Original" pattern, but with patented improvement. In this case the spiral spring acts upon the movable contact arm, so that when the switch is on, it is pulled down upon the surface of the fixed contact plate, ensuring in this manner certain contact. This form of switch with its various designs and modifications still meets with a large sale.

Another form of "Pioneer" switch is in different shapes and sizes. It is of the "double break" type, and is the subject of a further patent on the one above described, being actuated by two spiral springs, specially arranged in a closed cavity of the base. We are informed that over 100,000 of the "Original" and the two "Pioneer" types have been sold.

We also notice Lundberg's "Spiral" independent break attachment, fitted to switches. The key-piece is provided with a circular groove on its underside, in which is placed a spiral spring, one end being attached to the movable contact plate, and the other to the key-piece itself.



The "Midget Switch."

Many varieties of midget switches are on view; they work on the same principle as the "Pioneer" switches.

A novel form of ceiling rose for pendant lamps is shown. The twin wires pass through two holes arranged in the screwed mandrel of the base, which supports the cover. On this mandrel is an india-rubber ring, which, when the cover is screwed on, is compressed and forced down upon the two wires passing out at the base of the mandrel, firmly clamping them to the base, relieving the terminals of all strain, and preventing the flexible wire from being pulled through when any weight is attached or any pull given to it. Various patterns of wall sockets are exhibited, but as they are so well known, no description of them is needed.

The want of a simple, easy working and efficient switch has led to the introduction of a switch called by Mr. Lundberg the "Unique." It consists of a key, base and cover, all of porcelain. The base is provided with a square recess, in the centre is a small hole for the centre pin of the key to revolve in to ensure central working of the key in the hole of the cover.

The key is provided with two helical springs of metal ribbon wound round pins fixed into it. These springs, when the current is "On," make contact with two brass terminal plates, overlapping the sides of the square recess and connected with the circuit; when the current is turned "Off," these springs occupy a similar position against two other overlapping brass plates, not in connection with the circuit.

When the key is turned in the proper direction (*i.e.*, to the right), these helical springs are gradually wound up on the pins carrying them, and pass over the surfaces of the brass plates; on reaching the edges, the power absorbed by the springs comes into effect, and they fly off from the brass plates independently of the motion of the key, producing double independent quick "make" or "break" of the circuit (according to their initial position) in a manner far preferable to the objectionable "loose key" method so common in switches now in use.